PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

June, 1939

A. PRESCOTT FOLWELL, Editor — VOL. 70. NO. 6 — W. A. HARDENBERGH, Asso. Editor

Contents

TIMEWASTERS

The WPA problem of the May issue was absurdly simple for some of our big leaguers. The job mentioned can be done in three 16-hour days, if, as Mr. Easton says, "the big boss will let him." The brick and his little brother (called a dornick in the Dail), weigh 9 pounds, says Mr. Brady, with full corroboration on the part of Messrs. Easton, Blunk and others. Mr. Easton also forwards us a chart showing the solution of the tree problem. Arrange the trees in the form of a 6-pointed star and you have your six rows of four trees each, but only 12 trees. An "X" arrangement will also do the trick.

A variation in opinion on the young man who hurdled his car across a 20-ft. chasm —speeds from 54.7145 mph up. I haven't tried it yet, but I think that "up" will be necessary.

The Cat Situation:

After looking at the cover of Collier's Magazine with the optimistic cat on it, *Cleveland Engineering* (with whom we have a sort of cooperative agreement) bursts out with the following: (1) If 6 cats eat six rats in 6 minutes, how many cats will it take to eat 100 rats in 100 minutes. (2) A room with 8 corners and a cat in each corner, with seven cats before each cat and a cat on every cat's tail. How many cats were in the room? No pencil or paper allowed; just good straight cat thinking.

June Special for Young Men:

Henry bought a round diamond for the one and only girl, which diamond weighed 1.95 carats. (Henry being in the money). The "one and only" decided to have the diamond cut into a right circular cone shape, after which Henry spent the weekend figuring how much of the diamond would be left after the necessary amputations. Can you help him? Thanks to *Mr. Bevan.*

W. A. H.

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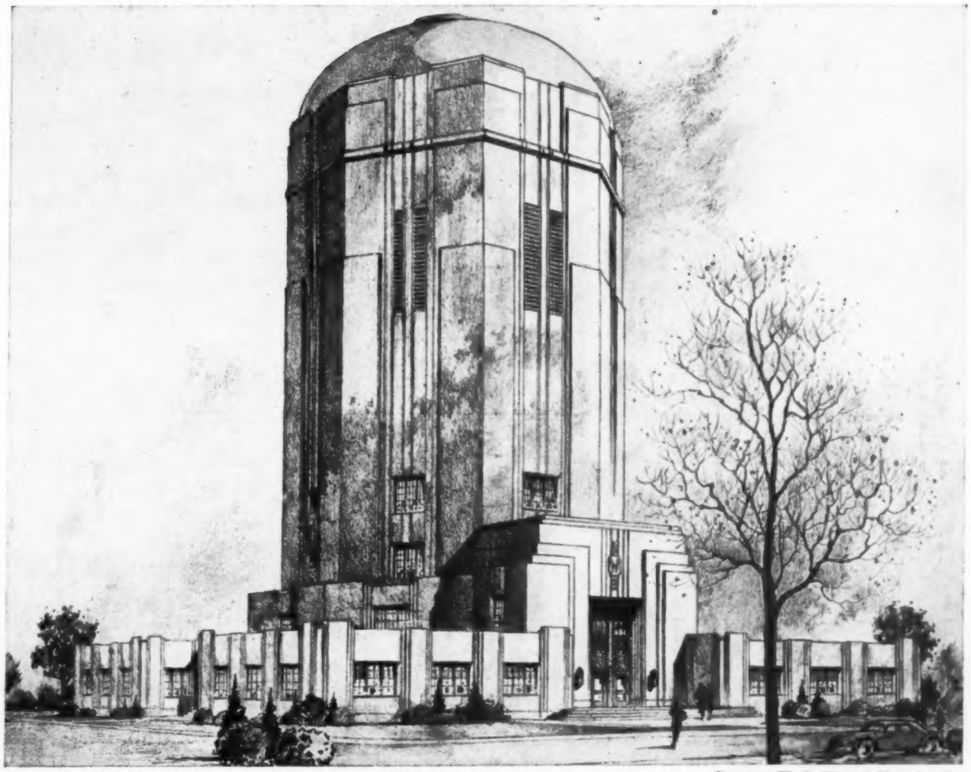


Courtesy U. S. Pipe & Foundry Co.

Unique and most artistic octagonal elevated water storage tank also houses offices of town government

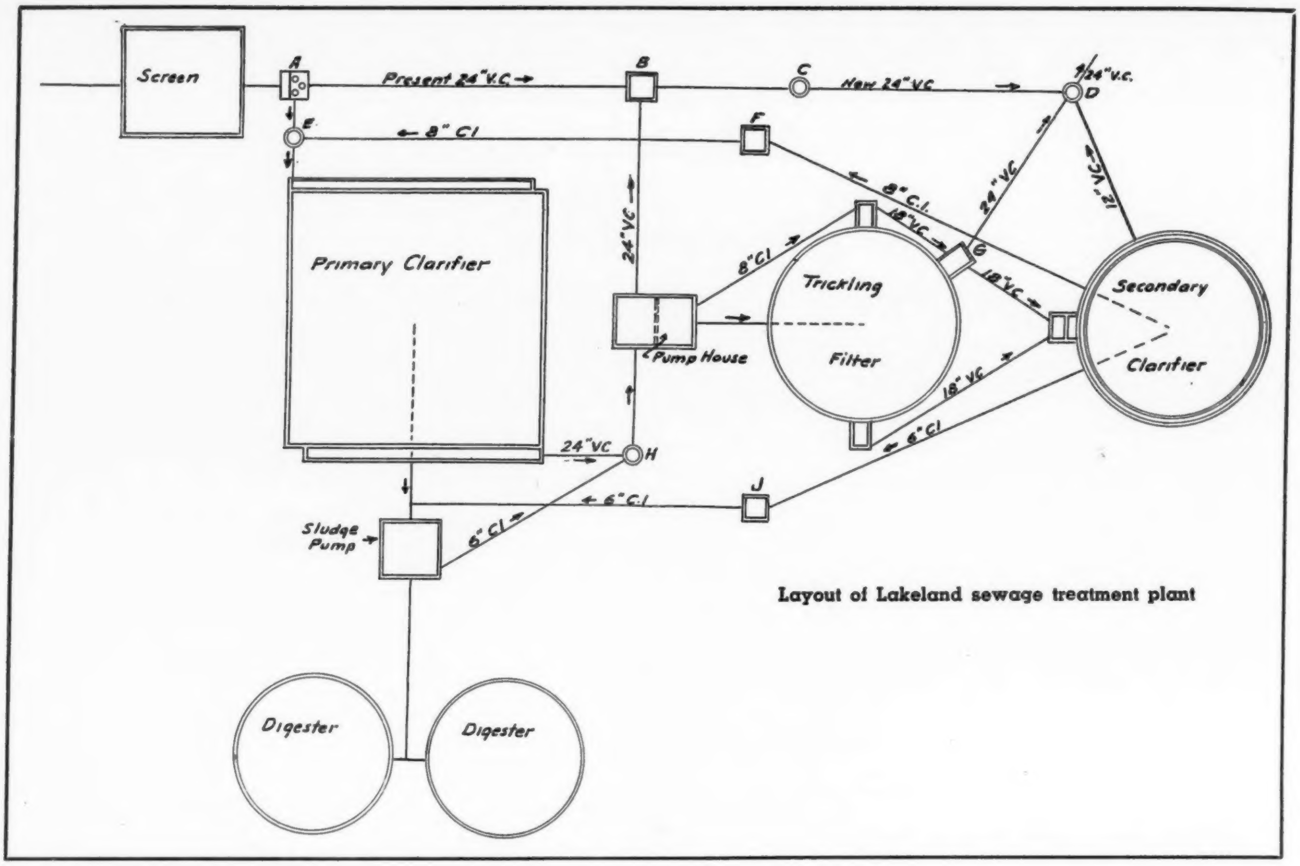
Water Tower and Town Offices Combined in an Artistic Building

IN CONSTRUCTING a complete water supply system for its twelve thousand population, including well, pumps, softening plant, elevated tank and distribution system, the Town of Lake, Wisconsin, built a most unusual elevated tank. The tank is of steel, but is encased in a concrete tower, the lower part of which is used as a four-story office building, surrounded by a large one-story building, all of which is used to house the offices of the town government.

The one-million-gallon steel tank, 65 ft. in diameter, is supported on a steel tower with 16 legs, its top 162 ft. above ground level. The steel work of the tower is enclosed by an octagonal concrete tower up to the domed roof of the tank, which shows above the tower walls. The steel work of the tower carries floors at four elevations, affording space for the town offices.

Surrounding the tower is a one-story structure of concrete, four recessed entrances dividing it into four quadrants, all built integrally with the tower. The building contains the water supply and softening plant, the offices of the Highway and Police Departments and all the other town offices except the Fire Department.

Because of the heavy loads and quicksand soil it was necessary to use approximately 12,500 ft. of steel piles 40 to 61 ft. long, each to carry 50 tons. These piles were furnished by the Union Metal Co. The tank and structural steel work were built by the Pittsburgh-Des Moines Steel Co. Permutit Co. constructed the softening plant. The 43 miles of iron pipe and fittings were furnished by the U. S. Pipe and Foundry Co. The entire project was designed by Wiliam D. Darby, consulting engineer. The cost is about $1,325,000, financed by a 45% PWA grant and the balance by water revenue bonds.



Layout of Lakeland sewage treatment plant

Modern Secondary Sewage Treatment With High Rate Sprinkling Filter

This Florida city of 25,000 population is one of the first to adopt the high-rate sprinkling filter. A 48 ft. filter is being built to furnish secondary treatment for an existing clarifier-digester plant; estimated to cost $20,000 less than a standard sprinkling filter.

LAKELAND, Fla., a city of about 25,000 population, is well named, as there are eighteen lakes within its limits, varying in size from one of 2,082 acres to 10-acre Lake Mirror, around which has been built the civic center. The business center has an elevation of 210 ft. above sea level—there are few higher spots in the state—from which the land slopes to about 135. As is the remarkable but very general rule in Florida, none of the lakes except the largest one has any visible inlet or outlet and yet there are no evidences of stagnation or pollution and very little growth of algae or other water vegetation.

The water supply of the city is obtained from deep wells and is chlorinated. The consumption varies from 0.85 to 1.0 mgd. There are few private supplies, and no trade wastes, so the sewage is practically wholly domestic, equal in volume to the water supply. It is collected by about 48 miles of sewers (13 miles built last year) and conducted by gravity to a treatment plant about 4 miles from the business center, where the water level in the primary clarifier is El. 114.0.

At present the primary effluent is discharged direct to Banana Creek which has little flow in the dry season and is choked with water hyacinth; as a result of which there is some putrefaction and abundant mosquito breeding; as a further result of which suit was brought against the city for maintaining a nuisance. The city won the suit, but decided to install secondary treatment anyhow, in which it is being assisted by WPA. This work is now nearing completion. It consists of a high-rate sprinkling filter using the Halvorson process, furnished by the Lakeside Engineering Co., pumps to lift the settled effluent to the sprinkler, and a secondary clarifier. It was estimated that such a filter would cost about $20,000 less than one based on standard sprinkling rates. The mechanical features of the filter cost $7,400. The total cost of the improvement will be about $40,000.

Utilizing the existing

(Continued on page 12)

Crushing rock along shoulder of road with a portable crushing unit

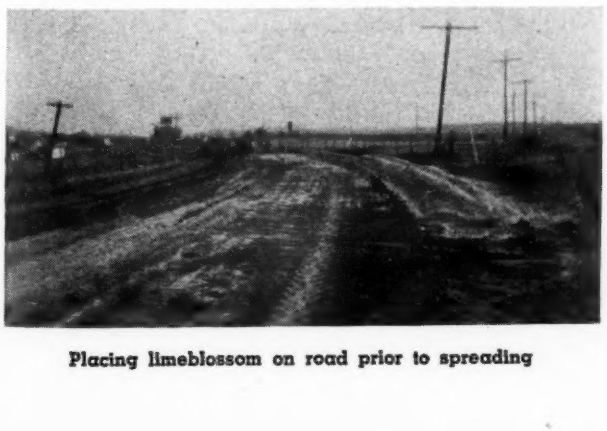
Surfacing With Limestone in Cloud County, Kansas

By A. R. SENTER
County Engineer, Cloud County, Kansas

With little money and an abundance of labor, Cloud County, Kansas, is able to construct a very satisfactory road using only local material—a limestone of shale-like structure which, when wet, seems to set up like cement and is locally called "limeblossom."

CLOUD COUNTY, Kansas, maintains a system of 205.5 miles of county roads, of which 43 miles are dirt, 3.5 miles are bituminous mat and 159 are crushed rock and "limeblossom" surface. The accompanying illustrations show construction procedures. Our most successful method of combating snow in winter is to elevate the roadbed above the adjacent fields. No surfacing is placed on a road which has not been properly graded. All but 30 of the 205.5 miles have been elevated and drained on a 60 ft. right of way.

For ten years past the county, being strictly agricultural and suffering from drought, dust storms and grasshoppers, has felt the hard times and been compelled to limit its expenditures. For several years it operated a sand and gravel plant on the Republican river to produce materials for road and bridge construction, but the 1935 flood damaged this beyond possibility of economical repair, and other material for stabilizing and surfacing the roads was sought. Also, to take advantage of labor offered by the various alphabetical relief agencies, it was necessary to sponsor projects utilizing the most labor.



Placing limeblossom on road prior to spreading

The first projects sponsored were for crushing rock for road surfacing. In various parts of the county, abundant rock could be picked up on the surface, and this was placed in windrows along the shoulders of the roads and crushed with a portable crusher, using 800 cu. yd. a mile. The State Highway Dept., however, was doing the same thing and hauling large amounts of this surface rock to central crushing plants for use on the State highways, and the supply conveniently available was soon exhausted and some other local material that would meet our requirements had to be found.

At several points in the western two-thirds of the county are large limestone deposits, but these vary widely in thickness and quantity, solid rock running from ½ inch to 10 inches in thickness. All these deposits, however, contain a material which we call "limeblossom," a shale-like material with the following analysis:

H_2O free and combined	approx. 1.52%
CO_2	approx. 36.84%
Acid insoluble & SiO	approx. 11.60%
R_2O_3	approx. 2.23%
CaO	approx. 46.42%
MgO	approx. .31%

The percentages of CO_2 and CaO are approximately those found in limestone, and the chemists who tested this material believe that, with weathering and pressure, it will ultimately become limestone. (We recently discovered that, mixed with water and sand, limeblossom makes a very satisfactory mortar for masonry.)

After experimenting, it was found that a satisfactory surface for county road traffic could be made by using 1500 cu. yd. of limeblossom and 200 cu. yd. of crushed rock per mile, the latter to create a non-skid surface and for use as a brush coat during maintenance.

Part of the limeblossom is obtained from old quarries, paying a royalty to the owners; but most of it from cuts made in grading road or cutting down high shoulders, thus improving grades and sight distance. In most cases the material is easily plowed and broken up, but blasting is necessary in some cases. During plowing and conditioning of the limeblossom all hard rock is removed. The conditioned material is hauled by truck and dumped along the shoulder of about a mile of the road, one cu. yd. per 3½ lineal feet of road, and spread by means of a No. 10 caterpillar diesel autopatrol, which has previously bladed the surface smooth and uniform. (If the surface has a hard crust, this should first be broken with a scarifier.) The limeblossom is windrowed to the center of the road and worked out from there to a width of approximately 24 ft., and bladed several times until smooth and uniform. Meantime, care is taken to remove any large or hard pieces of rock that may previously have been overlooked; which, if left in, would move under traffic and cause a hole. Next day the material is again bladed lightly; after which the surface is not worked in any way until it has received moisture. Following this blading, a windrow of rock crushed to pass a 1-in. screen is dumped along the shoulder at the rate of 200 cu. yd. per mile.

After the limeblossom has been thoroughly moistened by rain or snow, the crushed rock is spread over the surface; sometimes rolled into it with a roller but usually by traffic only. After the surface has dried out, the surplus rock is bladed back to a side windrow.

Such construction, with a 6-mile average haul, has cost $2,200 a mile for labor and $550 for equipment; relief labor doing all the conditioning, loading and feeding of crusher, and inspection of material during spreading. Two 15-ton crushers were used, and 3 yd. to 4 yd. trucks with bottom center dumps.

The only difficulty encountered in this type of construction was during dry months last summer, when the material dusted badly when spread and rain was long delayed. In one instance it became necessary for us to blade the material back into a windrow after it had been spread and wait for rain.

Some of our limeblossom sections are three years old and are in far better condition than sections where only crushed rock was used, in which the rock works loose during long periods of dry weather, and it is necessary to carry a heavy windrow of material along the shoulder or go to the expense of scarifying and mixing the rock into the roadbed. With limited local funds and plenty of relief labor, we consider the road surfaces described to be economical and practical.

Modern Secondary Sewage Treatment

(Continued from page 10)

plant supplemented by the new, the procedure will be as follows: Sewage passes through a Dorr self-cleaning screen. Then to the primary clarifier (diversion direct to the creek if desired), which is rectangular 60x60 ft., provided with a Dorr sludge remover. The effluent then flows to a pumping station, where it is lifted to the sprinkler against a maximum dynamic head of 20 ft. The filter stone has a surface elevation of 123.5. The underdrains discharge into two manholes, each provided with a motor-operated ventilator on top and baffles to insure entrance of air into underdrains and not into outlet. From these the effluent goes to a secondary clarifier which is circular, 40 ft. diameter, 8 ft. side depth and 10 ft. center depth, provided with a motor-driven sludge collector; and then to the creek.

Sludge from both clarifiers is pumped into two circular digestion tanks (used alternately or together, but not in series) 35 ft. diameter. Sludge from these is drawn onto three sludge beds, one covered for use in rainy weather. Sludge is drawn 18" to 24" deep (sometimes deeper) and dries to about one-fourth this depth, when it cracks into cakes. It is then turned over by hand (prison labor is used) and air dried on the other side. It is then dry enough to be pulverized in a grinder. All the pulverized sludge is used by the city as fertilizer on its parks, golf course, etc.

The various parts of the plant are interconnected so that operation may be varied in several ways: Either screened sewage or clarifier effluent or filter effluent can be sent direct to the creek. Screened sewage can be sent direct to the secondary clarifier. Secondary clarifier contents, liquid or solid, can be returned by hydrostatic head to the primary clarifier influent, or to the digestion tanks.

The New Sprinkling Filter

The sprinkling filter is designed for a maximum rate of flow of 1,248,000 gpd, of sewage having a maximum strength of 250 ppm of B.O.D. based on 24 hr. composite sample. It is 48 ft. diameter; 8 ft. deep from top of wall to underdrains, with 2.5 ft. freeboard. The drains are vitrified channel block furnished by W. S. Dickey Co., covering the entire bottom and draining to a diametrical channel 14" wide by 4" to 6" deep which discharges into the two ventilating manholes. The stone laid on this floor is specified to be crushed dolomite, quartzite, trap or hard limestone, screened to pass 3" circular openings and be retained on 1½" openings, 50% to be retained on 2" openings. The stone must meet the sodium sulphate soundness test of the A.S.T.M. 089—35 T.

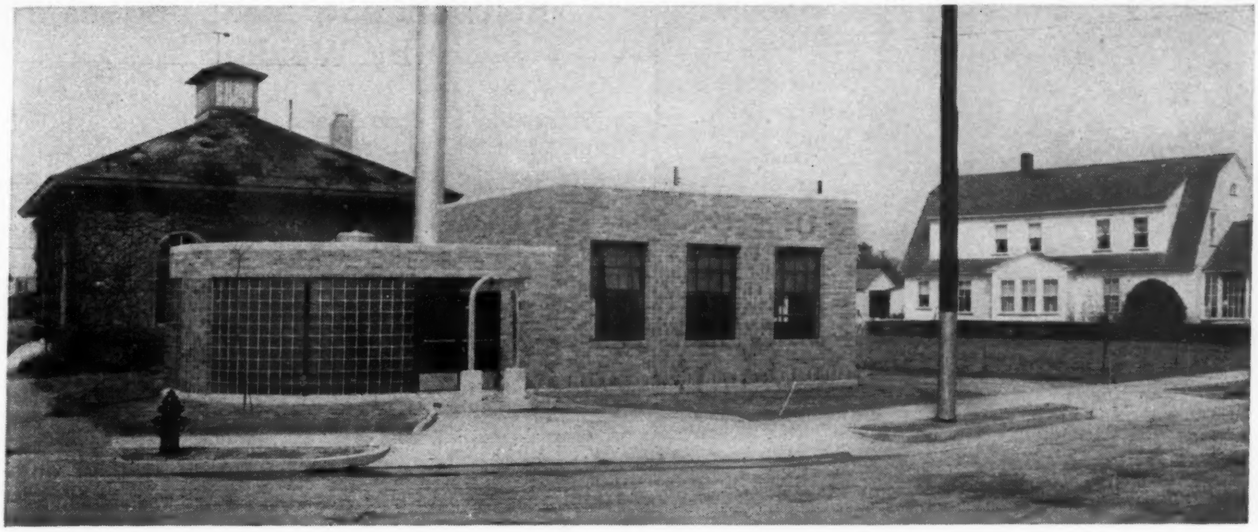
Each ventilating manhole has on top a ventilating fan, motor-operated, with a capacity of 900 cfm at ¼" static pressure.

The distributor is a "reaction type rotary distributor," with six arms, carrying a total of 200 nozzles uniformly distributed over the surface of the filter, so that, even when the distributor is at rest, with a flow of 870 gpm, it is guaranteed that 25% to 30% of the filter surface will receive continuous rain-like spray with a head of 3 to 4 ft., and that the distribution will be satisfactory with half this head. With the sprinkler revolving, the spraying of each unit area will be practically continuous. As the nozzles have round throats not less than 1¼" diameter, clogging is believed to be improbable.

The new pump house is 16 ft. square inside above ground, plus a wet well 7.5x9 ft. below ground. The present 24" outlet main passes through the wet well and will continue in use until the new plant is ready to operate, when the section inside the well will be broken out; the portion from there to the creek remaining to serve as an emergency outlet.

There are four pumps, two of 300 gpm and two of 600 gpm (one of the latter will normally be held in reserve), the smaller operated by 3 hp. motors, the larger by 5 hp., with not more than 1,200 rpm. These are automatically operated by float switches for 3-stage control, having mercury contacts for 220 volt, 60 cycle, 3 phase A.C. The first 300 gpm pump starts with sewage in the well at elevation 107.8 and stops at El. 107.4. If the sewage rises to 108.2 the small pump stops and a larger one starts; at 108.6 both pumps are in action; and at 109.0, all three pumps. The overflow is at 110.0.

Earle E. Baird, of Lakeland, is consulting engineer. Construction is in charge of R. E. Bates, city engineer.



The new pumping station is in a fine residential district.

Cape May's New Diesel Sewage Pumping Station

By E. SCHOONMAKER

LAST summer the old Madison Avenue sewage pumping station of Cape May, N. J., became wholly inadequate through obsolesence. The old gas engines, needing constant attention, could not be operated for more than two periods a day. The pumps, as a result, could not handle the flows resulting from normal increase in population, the sewer lines overflowed, and a serious health menace was created. Perring & Remington Company, consulting engineers, of Camden, N. J. and Baltimore, Maryland, who had been engaged to conduct a thorough survey, recommended a new works so regulated as to have a capacity varying from 0.5 mgd to 5.5 mgd. To achieve this and obtain simplicity and dependability, final decision was made on Diesel engines direct-connected to non-clogging, horizontal sewage pumps.

The installation of a 4-cylinder, Model 36, 4¼ Diesel engine, direct connected to a 6", 1,200 gpm sewage pump and a 6-cylinder, Model 36, 5½ Diesel engine, direct connected to an 8", 2,800 gpm sewage pump was completed late in 1938, thus providing a maximum range of speed regulation without the use of speed reducers. By eliminating all mechanical conversion losses in this manner and coupling this operating advantage with sewage influent regulation, the entire flow is handled with a minimum of equipment. In this way, the engineers gained investment and construction economies without impairing utility, resulting in the low rate of $1.50 for pumping one million gallons of sewage out to Delaware Bay, approximately 19,000 feet distant. The average flows per day are:

Average summer flow	1,500,000 Gallons
Average winter flow	1,000,000 Gallons
Normal rainy weather flow	3,000,000 Gallons
Heavy rainy weather flow	4,000,000 Gallons

Prior to constructing the foundations for this equipment, test borings were considered necessary on account of the proximity of so much sand and water. As a result, the engineers specified special pile founda-

Engine and Pump Equipment

Diesel Engines: 1—Fairbanks-Morse, 4 cylinder Model 36, 4¼" Engine with effective speed control from 750 RPM to 1200 RPM. 1 — Fairbanks-Morse, 6-cylinder Model 36, 5½" Engine with effective speed control from 400 RPM to 750 RPM.

Non-Clogging Sewage Pumps: 1—Fairbanks-Morse 6" horizontal sewage pump with maximum capacity of 1200 GPM. 1—Fairbanks Morse 8" horizontal sewage pump with maximum capacity of 2800 GPM.

Circulating Water Pump for Sewage Pump Bearings: 1—Fairbanks-Morse 2 HP, 3-60-220/440 volt, and 3450 RPM builtogether pump with pressure tank and automatic control.

Silencers: 2—Maxim Silencer Co., Hartford, Connecticut.

Well House Equipment

Discharge venturi
Chain hoist
Combination bar screen and grit removal mechanism by Link Belt Company
Water level indicators and alarm
Automatically controlled rake cleaning attachment.

Engine Accessories

Engine Starting Batteries: Exide—2—24 and 32 volt batteries; one for each engine.

Oil Filters: 5—DeLuxe. Two used on small engine, three on larger unit (lubrication).

Oil Filters: Purolator—One on each engine (fuel).

Tachometer: Reliance—one for each unit.

Air Cleaner: Burgess—Two

Thermostatic Circulating Water Control Switches: Detroit Lubricator Co. on both engines.

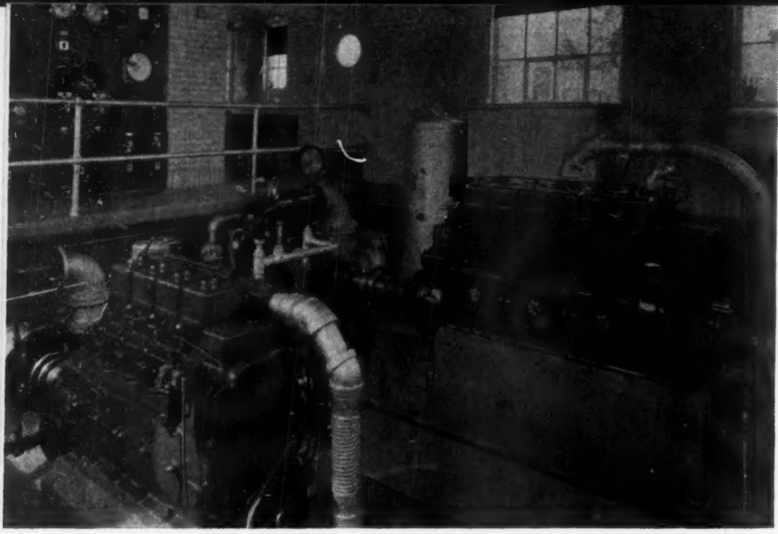
Thermometers: D. P. S.—Chicago.

Couplings: Falk Steelflex on both engines

Battery Charging: Rectigon—Two 24 and 32 volt for charging starting batteries.

Switchboard Equipment

Westinghouse circuit breakers
Fairbanks-Morse "Lube Oil" meters
Brown pyrometer
Oil and circulating water alarm
Edwards electric horn
General Electric relay switch
Westinghouse inflow water level meter
Schwarze electric high and low water alarm
Simplex "Venturi" meter



The interior of the new Cape May plant is neat and clean.

tions, which were put in and insulated from the building by cork and bitumastic foundation mats and side walls. By installing the engines and pumps in this manner, the possibility of future mis-alignment was averted and vibration reduced to the near-perfection mark. Also, Maxim silencers were used on each engine, making possible a very quiet installation.

The use of other simple operating safeguards also contribute to "top" engine performance. An automatic engine "howler" to warn against insufficient cooling water and lubricating oil is installed. The bearings of each sewage pump are protected by a positive supply of cooling water automatically furnished by a Fairbanks Morse pressure system. An alarm indicates the high and low water levels in the receiving wells, so that operating adjustments can be made at the critical points as the occasion demands. The quality of performance is further enhanced by the use of oil filters, air cleaners, thermometers and thermostatic circulating water controls on each of the engines. The pumps, operating with 20-ft. suction lift, are also safeguarded against lost suction by check valves in the suction lines, which obviates the necessity of using the Nash primers installed on each pump, which are designed for intermittent service.

The advantage of operating according to demand made it unnecessary to enlarge or add to the present receiving well. This fitted in with the engineer's plan to make the screening and grit chamber an integral part of the suction well. Reached by a spiral stairway, it includes a chain hoist for removing screenings; adequate air ducts to the ventilation stack in the rear of the plant; grit chamber; hopper bottom grit channel; inverted rake cleaning attachment; gas tight roofs over the wells, moisture-proof float switches operating motorized sluice gate and water level indicators and alarms. Combination stop plates and adjustable weirs are also installed in the 18" discharge channel to the suction wells, which permits the diversion of sewage into either pump suction compartment and the control of the sewage level within the screening chamber.

The engines, pumps, switchboard and accessory equipment are installed in a superstructure immediately adjacent to the well housing, all of which was constructed by Thomas Proctor & Sons, contractors of Long Branch, New Jersey. They erected a very attractive cover for the entire plant, utilizing glass blocks over the well end and faced brick for the balance. The atmosphere of the whole plant is one of wholesomeness, gained from the clean impression created by the use of light buff brick work in the engine room, grey painted floors and a white painted well shaft. Without question, it is New Jersey's most outstanding installation of the year.

Rejuvenating Steel Bridges by Welding

Porter County, Indiana, has on its highways 375 bridges of all types. Of these, 150 are pony truss steel, and when, in 1936, A. J. Rader became county road supervisor he learned that many of them were alarmingly weak. The partial failure of one of 50 ft. span, due to serious rusting of the base of each of the four end posts and the adjoining bottom chords, emphasized the necessity for immediate action.

Supporting the bridge temporarily on piles, the rusted posts and chords were removed, trucked to a bridge plant, and the rusted parts replaced by electrically welding new metal (this being suggested by the county engineer), and returned the same day. Meantime the bridge was wire brushed and spray painted. Several corroded I-beams were removed from the deck and replaced and a new treated timber plank floor laid.

The total cost was $80 for the welding work, $75 for three new 50-ft. I-beams, $170 for 2400 ft. of plank, $70 for labor and $5 for paint; giving a bridge practically as good as new.

After this experience, 15 bridges were rebuilt in the same way and 27 others repaired, a special crew of WPA men under an able bridge foreman being organized for the purpose. The county's equipment for bridge repair includes pumps, concrete mixer, acetylene torches, steel sheet piling, steel forms for concrete floors, a paint spray machine, and necessary small tools. A card index is kept of all bridges, which are identified by numbers, and on this are entered records of all repair work done.

The above information was given in a paper read by Mr. Rader before the 25th Annual Purdue Road School.

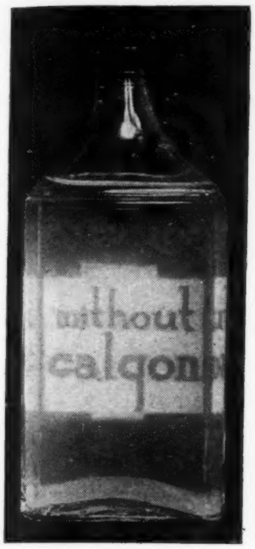
Minneapolis Makes City Buildings Survey With WPA

Allocation of WPA funds to finance the first complete survey ever made of city-owned public buildings in Minneapolis has been announced by H. L. Richards, Minneapolis district Works Progress Administration director. The building survey was begun November 21. About 12 persons will be employed in making the survey, which will include fire and police stations, bath houses, tool houses, oil plants, water and sanitation department buildings and the auditorium.

Fred T. Paul, city engineer, has reported to WPA that there are more than 100 city-owned buildings in Minneapolis for which the engineering department has no record as to type of construction, use to which put or condition of repair.

Project workers will make complete floor plans, give use to which put and full details as to condition of all buildings, Mr. Richards said. A. M. Larson, architectural engineer of the city, will act as project supervisor. Completed plans will assist the engineering department to modernize and maintain the buildings without the necessity of making individual surveys.

The need for such a survey was shown when an addition was contemplated for one of the water department buildings. The lack of any building plan, relative to the type of construction concerning boiler size and capacity and ability of present electrical installation to accommodate the additional load, made necessary a complete survey of the buildings before tentative plans could be drawn. With the WPA building survey completed, such a special, individual survey will not be necessary.



Stabilization and Corrosion Control By Threshold Treatment

F. T. REDMAN
Hall Laboratories, Pittsburgh, Pa.

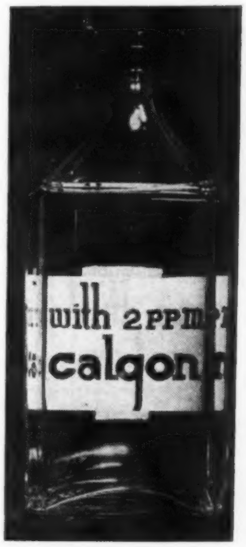
OF GREAT interest to all municipal water works operators is the introduction of a new and positive method for the control of calcium carbonate precipitation from hard waters or (unstabilized) lime-treated waters.

The addition of lime or other alkaline chemicals for corrosion control has often resulted in excessive deposition, as has also the pumping of an unstabilized lime-soda softened effluent. When waters of the above types are treated with 1 or 2 parts per million of sodium hexametaphosphate, however, complete stabilization is obtained, thus preventing scale in hot water heaters, on filter sand, and in the distribution system.

Sodium hexametaphosphate (sold under the trade name of Calgon) had, prior to the discovery of its use as a water stabilizing agent, been used extensively as a conditioning chemical for boiler water and as an adjunct to soap due to its peculiar property of forming a soluble calcium complex. These applications require fairly large amounts of Calgon, however, and it was readily recognized that the maintenance of these concentrations of the chemical would be prohibitive economically in a municipal water supply. Laboratory research and many plant applications have shown that sodium hexametaphosphate exhibits surface-active properties at very low concentrations and notable among these effects is the ability to delay and even prevent precipitation from highly supersaturated solutions of calcium carbonate. Maximum effect is obtained at a concentration of 2 parts per million of the metaphosphate, which will prevent precipitation for periods of five days or longer in waters containing as high as 200 parts per million of $CaCO_3$. This is demonstrated in Figure 1.

Corrosion Control.—From Figure 1, it can readily be recognized that this treatment is of value in the maintenance of a high pH value which is desirable in order to allay corrosion. The addition of 1 part per million of metaphosphate enables the water plant operator to carry pH values of 9.5 or even higher, if desired, to the farthest reaches of the system; whereas without this stabilizing agent, attempts to carry high alkalinites in soft corrosive water have in most cases resulted in precipitation near the treating plant and a resultant drop in pH throughout the rest of the system.

Softened Waters.—Municipal supplies which must be treated for aggressiveness toward iron are not the only ones which have problems involving the precipitation of calcium carbonate. Plants practicing lime or lime-soda softening are unable to obtain complete reactions in the settling basins. Consequently, filter sands grow with deposits of $CaCO_3$ and pipeline incrustation occurs.



Effect of 2 ppm of metaphosphate on water of 150 ppm hardness to which 100 ppm of sodium carbonate was added.

Recarbonation of softened water, which has been widely adopted, has invariably introduced troublesome problems. Maintenance of equipment alone consumes plenty of time and money. Control of dosage is difficult because the alkalinities must be maintained within very narrow ranges by the introduction of more or less CO_2 gas, according to the condition of the water being treated. If the water is carbonated too far, "red water" complaints will be prevalent and, if the introduction of the gas is stopped before reactions have become sufficiently complete, deposition will occur in places which in all probability are by far the most inconvenient. Even with accurate control, recarbonation has not been entirely satisfactory because the "stability pH" is too low for best results in corrosion control.

In contrast to this treatment is the maintenance of

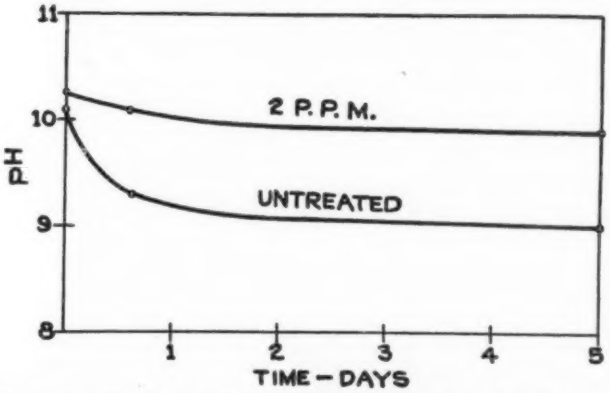


Fig. 1—Stabilization of Calcium Bicarbonate Water Containing 200 ppm. of $CaCO_3$ by 2 ppm. of Sodium Hexametaphosphate. Waters prepared by mixing equivalent amounts of sodium carbonate and calcium chloride.

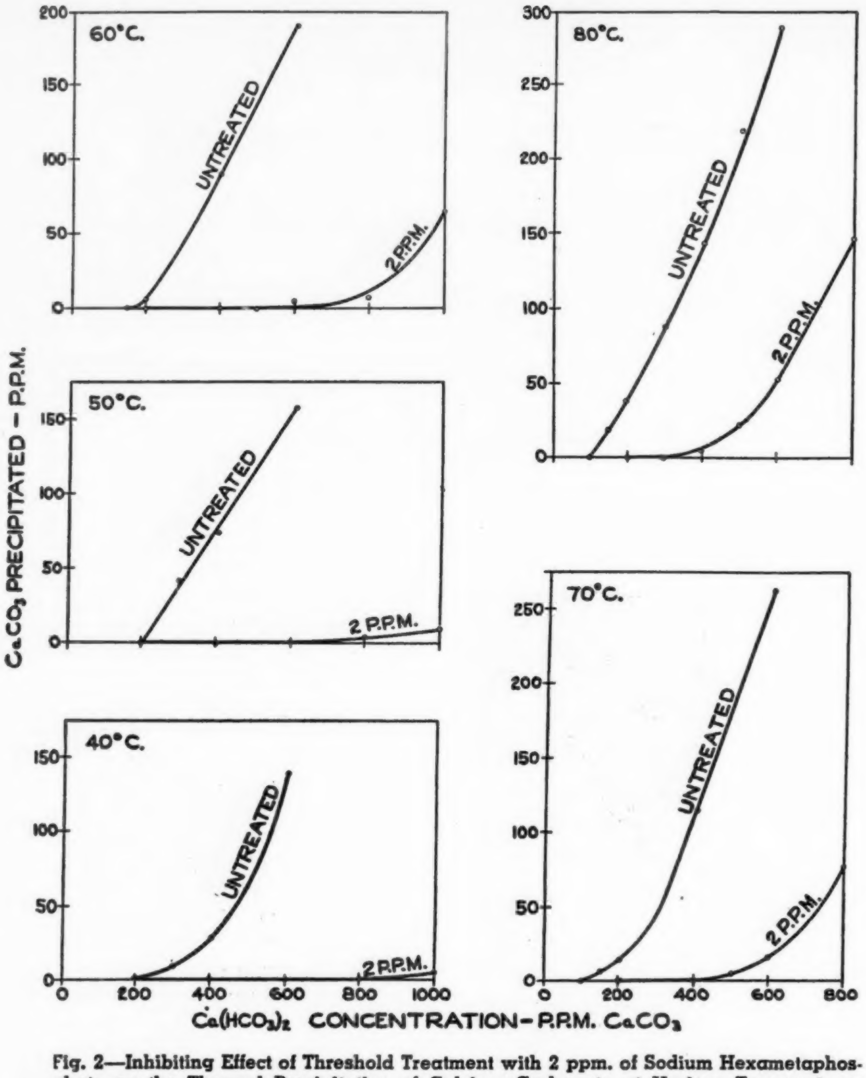


Fig. 2—Inhibiting Effect of Threshold Treatment with 2 ppm. of Sodium Hexametaphosphate on the Thermal Precipitation of Calcium Carbonate at Various Temperatures and Concentrations of Calcium Bicarbonate. All tests conducted for 1 hour at stated temperature—0.5° C.

eliminate this scaling condition, but sufficient reduction in the amount of $CaCo_3$ precipitation is made to prevent the burning out of the heating coils. It has been noticed in laboratory work that decreasing stability was noted with increasing temperature, but even at 60°C 800 parts per million of $Ca(HCO_3)_2$ was held in solution for a heating period of one hour with 2 parts per million sodium hexameta-phosphate. At temperatures lower than this, far greater quantities of bicarbonate hardness were stabilized for increasingly longer periods of time. This is shown in Figure 2.

Threshold treatment, of course, has found other uses where incrustant waters and alkali-treated corrosive waters are used in industry. Recirculating systems serving turbine, distillery, and refinery condensers, and Diesel-engine cooling jackets are a few of those to which this treatment has already been applied. Treatment cost has been ludicrously small as compared with former cost of descaling and replacement due to corrosion, and a very flexible, simple procedure has taken the place of former worry and expense.

There is no doubt that acceptance of the stabilizing influence of metaphosphate in water will be widespread in the municipal field because it allows the maintenance of a high pH when corrective alkali is added to an aggressive water and also permits the maintenance of scale-free systems both in the distribution lines and in the consumer's hot water supply system.

1 or 2 parts per million of the easily applied Calgon. Feeding devices may be of the simplest design and entail no great expense. No narrow control is necessary and the operator may maintain any pH which he considers best for his water and plant. Threshold Treatment at such a plant may be applied to either the filter influent or effluent, depending upon what path the operator chooses to follow. If clean filter sand is desired, the metaphosphate should be introduced before the filters, and thus prevent any drop in alkalinity on the sand grains. In some cases, the advantage of this small amount of softening on the sand is preferred and the water then should be stabilized with metaphosphate as it goes to the clear well.

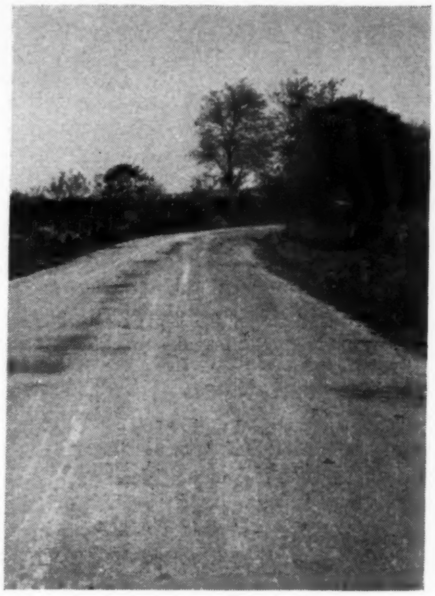
Hard Water Supplies.—Aside from the water supplies of the country which are softened or alkali-treated for corrosion control, there are numerous cases in which naturally occurring hard waters high in bicarbonate are supplied, with no other treatment except chlorination. In many cases these waters fill pipelines with scale due to the loss of CO_2 and a stabilizing treatment would be highly desirable from an operating standpoint. The principal trouble occurs on heating these water supplies for domestic use, when excessive scaling of the heating equipment occurs and ¾" copper coils are rapidly reduced to pencil size or even entirely closed. The maintenance of 1 or 2 parts per million of metaphosphate in these waters may not completely

Immunizing Workmen From Poison Ivy

The use of Poison Ivy Serum to establish immunity in one group of workmen developed these figures: 55% were not infected by poison ivy; 30% were definitely benefited, while the balance of 15% received no benefit. In some cases the full cubic centimeter shot was a little heavy, and better results were obtained by giving two half-shots. An internal treatment for poison oak, used as a curative as well as an immunizing agent appeared to be effective in 90% of the cases reported. In an area where one contractor immunized all employees, and another did not, the first used 66 shots plus 11 treatment shots, having one lost-time case of four days in 9,000 man-hours of exposure. The second had 42 cases of infection, of which number 28 were cured with one shot, while twelve were lost-time cases, with 72 days of lost time with 19,000 man-hours of exposure. One of these lost-time cases ran for 35 days.

Novelties From Illinois Sewers

Illinois operators must be prepared to find anything in their sewers and sewage plants. Among recent findings are: Monmouth—a slug of human hair 4" in diameter and 12" long. Litchfield—a rabbit from a raw sewage pump. Lincoln—a kerosene stove.



Slag and Calcium Chloride Give Good Base for Black Top Surface

By E. L. MILLS
County Engineer, Harrison County, Ohio

The dusty, uneven slag surface of the main street of Deersville, Ohio, was scarified and bladed smooth and given a 3 inch surface course of slag and calcium chloride, wet and rolled. The smooth surface stood up perfectly under last summer's traffic and, with a light tar surface treatment, under that of last winter also.

TO MAINTAIN a system of county highways, say 200 to 400 miles, and keep improving their condition to meet ever-increasing demands, spending only the amount that the average rural county today has available, is a job to tax to the limit the thought and experience of any county engineer. For possibly 90 percent of the mileage (in southeastern Ohio, at least) is surfaced with loose crushed gravel, stone or slag which was compacted by traffic and kept smooth and passable by dragging or use of blade scrapers. This cheap and quick way of getting the farmer out of the mud came into prominence about 1920, and during the next ten or fifteen years almost every farm-to-market road was widened and surfaced with these materials.

Assuming that 1000 cu. yd. per mile of graded gravel, stone or slag was used in such construction of an 18 ft. roadway and in maintenance during its first five years of use, this means that a total average depth of 3½ in. has been applied. But at the end of that period not more than 2 in., probably less, of the material remains; the rest either has been poked so far into the subgrade during wet seasons that it has been lost, or during dry seasons has been abraded and blown from the road as dust.

County engineers are realizing that this type of road will not support permanently any kind of bituminous surface; that the edges are weak and break down first, usually during periods of thaw and excessive moisture; and that the public demands that more of such roads must each year be developed into all-year hard-surfaced roads.

This county is considering three different methods of surfacing such roads with bitumen, taking into consideration, for each road, its stability, subgrade condition, moisture condition, and present and prospective traffic load. The first and most expensive, suitable where aggregate is cheap and plentiful, is recommended for the heaviest travelled roads. In this the center of the old road, where traffic has consolidated it, is left intact, but a wedge-shaped trench is cut along each edge of the roadway, say 5″ deep at the outer edge tapering to nothing toward the center, the excavated material being pushed out onto the berm. On this, aggregate is placed and rolled in two courses to a total depth of 7″ in the center and 12″ on the sides, to serve as a foundation for the bituminous top course. This is expensive, and the average county can afford it on only the most important routes; but it should be used on these where there are suitable local materials and WPA forces available.

The second method has been used successfully in recent years by Harrison County to improve, at nominal expense, roads made of traffic-bound crushed and graded blast furnace slag—the cheapest material available. It made an excellent road but, being more porous and bulkier than other materials, it tends to break down after freezing and thawing for a few years, and loss of material as dust leaves it granular and unable to carry heavy loads during thawing periods.

An illustration of the use of this method is the recent improvement of the main street of Deersville. This had

The street after stabilization

been surfaced first with railroad ashes, later with graded slag kept smooth with a drag. It was very dusty in summer, not too solid in soft weather, and its cross-section and grade were not regular or smooth, and the village council asked help of the county to improve it.

Beginning in early summer, a motor grader unit scarified the street to a depth of 3" and a width of 22 feet, blading the material enough to get it uniform throughout, and ridging it along the sides. Then it relaid it in two courses, using a sprinkler and a roller to get good compaction. This operation removed most of the waves and irregularities in the old street surface. No additions were made to the materials already on the street, although there was incorporated in them a very small amount of clay from the subsoil, which served as a binder.

The blast furnace slag, graded to all pass 1" opening, 70% to 85% by weight to pass the ⅜" sieve, and 30% to 50% to pass the No. 10 sieve was placed in a windrow on the street, sufficient in amount to build on the surface a three-inch top course. This was levelled off and a volume of red clay was placed on the slag, in amount equal to about 10% of the volume of slag. The plasticity index of this clay ranged from 50 to 70. After allowing the clay to dry, it was broken down and thoroughly mixed with the slag, about 1½ pounds of calcium chloride per square yard also being added to this mix. Then, after thorough moistening with a sprinkler (or by rain), it was spread over the surface with a motor grader in a moist condition, in two thin courses, and rolled, each course separately. This produced a very smooth riding surface. The finished street, composed of the gray slag, chloride and red clay, was stained to a slight red color.

It was not known at this time whether anything further would be done with the street that year and both bottom and top courses were given a liberal crown, which is best with a road surface like this. However, the surface stood up perfectly under traffic during the summer, so it was decided in the fall to put a light treatment of 2/10 gallon C.T. (light) tar and about 10 pounds of pea gravel per square yard over the street, to protect the surface during the winter. This very inexpensive maintenance was applied early in November, and has successfully protected the surface over the winter months, so that this spring not a break shows. It is of course planned to give it a heavier skin treatment this summer.

The obvious advantage of placing a light bituminous seal on the surface of a stabilized road of this type within a short time after it is finished, is to hold perfectly the smooth riding surface, to avoid patching and the resulting roughness developed, and because a cheaper skin or blotter treatment will then suffice instead of a surface mix or more inexpensive top course later.

Various other methods of procedure, patterned in general after the various forms of oil stabilization, are being tried in this district, and have largely been satisfactory. For complete success they require laboratory control of materials. Scarifying down to the subgrade and the addition of sufficient amount and kind of new aggrgate and cheap binders, and the redistribution in place in thin courses, is the general method used.

Some county engineers are of the opinion they can begin to treat their roads with oil about two seasons before putting on the surface, and some practice the method of simply scarifying, adding more material to the road, and then compacting it and applying a mixed-in-place black-top surface. Due to the inherent weakness of the road base it is doubted that these methods will be more than temporarily successful.

Garbage Collection and Incineration in Milwaukee

Garbage is collected and incinerated in Milwaukee under the supervision of the Bureau of Garbage Collection and Disposal, which was established in 1923; collection having been previously in charge of the Bureau of Street Sanitation, and incineration in charge of the Chief Engineer of Power Plants.

Garbage is collected once in 7 days from July to October inclusive, once in 8 days during June and November, in 9 days during May and December, and once in 10 days during January to April. The changes in frequency are coincident with changes in district boundaries, there being 36 routes in winter and 45 in summer served by 2-horse trailers; also, collection is made by a commercial truck operating full time and another usually one day a week. Each trailer is served by a driver (who also loads) and a helper; each truck by a driver and 2 helpers. The starting time on winter schedule is from 4 a. m. to 6 a. m., and on summer schedule 2 a. m. to 4 a. m., a day's work being 8 hrs. By starting the trucks at intervals during the 2-hour period and routing them over different streets, traffic hazards and public criticism are reduced.

Each trailer collects a load in two hours, leaves it at a designated parking place, where he finds an empty trailer, which he then fills. A truck with a train of empty trailers goes to the several parking places in regular order, leaving a trailer at each; then reverses his course and picks up the filled trailers and takes them to the incinerator. Here the loads are weighed and a record made of weight, route, trailer number and time. The loads are then dumped into a pit, and the trailer is washed with a strong stream of water. The average length of haul of the trailer trains during 1938 was 4.8 miles.

Charge is made for collecting "commercial" garbage (from other than private households), but those wishing to haul their own garbage may do so; no charge is made for incinerating it. Of the 51,866 tons of garbage burned in 1938, 4,122 were brought by private parties. Collecting 47,764 tons in 1938 cost $267,915, or $5.61 a ton, or 42.86 cts. per capita. In addition, $4,165 was spent in collecting waste oils in a 500-gal. tank truck equipped with a power pump. This oil, which formerly was discharged into the sewers and interfered with the sewage treatment, is used as fuel in the incinerator.

There are two incinerators, located about a mile from the downtown section. One, built in 1909, contains four 6-cell furnaces, the gases from which heat a 200 h.p. water tube boiler and pass through an air preheater on the way to the 150 ft. chimney. It was guaranteed to burn 225 tons, 40% of which is combustible rubbish. (In 1938 the garbage collected contained only 10% rubbish, waste oil, ashes and cinder.) The steam generated is used to produce electricity. About 65 kwh are generated per ton of garbage, approximately 9 of which are used in and around the plant. The second incinerator, built in 1930, has three 3-cell furnaces, using 110 lbs. of coal per ton of garbage containing 65% moisture. This was built to be used during the peak garbage season.

The clinkers from the old plant are pulled out of the firing door and drop through a door in the floor in front of the furnace, directly into a trailer. In the new plant a special dumping plate is provided inside each furnace to allow the clinkers to drop without creating a dust.

Incinerating 51,866 tons of garbage in 1938 cost $135,054, allowing no credit for power created, which is worth about ⅝ ct. per kwh. This gives $2.64 per ton, or $2.58 allowing for current generated and used.

The Editor's Page

Education Opportunities for the Water Works Superintendent

There has been a strong tendency toward extending licensing requirements for water works superintendents, and most of the superintendents themselves are in favor of this. A survey made by this magazine about two years ago showed that nearly 60% of them were unqualifiedly in favor of licensing, and only 19% as strongly against it. The requirements for licensing, however, impose on the licensing authority the duty to provide educational facilities to enable the superintendent to acquire the knowledge necessary to gain his license.

In this regard the entire industry has been backward. It is true that the state sanitary engineers have fostered short schools and regional meetings which have accomplished a great deal. Our two large water works associations, on the other hand, have done very little for the small-town men. Too often these men are unable to get away from home to attend short schools, and there has been nothing available to them for home study.

The editors of this magazine have cooperated with the leading correspondence school in preparing a course that will meet all needs for training superintendents and operators. This will be available in the fall. In the meantime, over the past two years, it has published several long and complete articles, designed to provide a basis for study. Another appears in this issue. Others are in contemplation. These are in response to the many hundreds of appeals for such material that we have received in the past two or three years. We hope they have been helpful, and judging from the demand for them and the letters we have received about them, they have been. We shall be glad to hear from superintendents regarding their needs, and will do our best to meet these.

Studying the Nation's Watersheds

A joint detailed study of eighteen of the country's important watersheds is now being made by the Forest Service, the Soil Conservation Service and the Bureau of Agricultural Economics. These watersheds range in size from 200 square miles to 17,000. Eventually the study will cover 200 major watersheds, but the eighteen now being covered should provide a representative cross-section.

Primarily these studies will have to do with flood control, but they should yield valuable information to the water works engineer also, and the results of the studies, when translated into work done, should be of still greater service.

In this project, the Soil Conservation Service will study the effects of soil utilization on soil conservation, run-off and retardation of run-off; the Forest Service will study principally the relation of forest cover at present and needed, its effects in reducing erosion and heavy run-off, and forest management. The Bureau of Agricultural Economics will be concerned with estimates of flood damages and proposed preventive measures, and the total effect of proposals for prevention.

Super-Highways and Sufficient Highways

A good deal of space in the technical magazines has been devoted to super-highways and to "highways of tomorrow." We hope that this will not obscure the fact that *more* all-weather, low-cost roads also are badly needed. Around some of our big cities, 4-lane, 6-lane or 8-lane highways are perhaps the answer to traffic congestion. But in other places, the greater need is for the road that can be traveled all the year around, that is within the cost range of the average township, county or city, and that will facilitate safe and rapid travel.

The need for a transcontinental super-highway has been pretty well exploded, but those who appreciate that most of the traffic is local traffic are probably still in the minority.

Putting the Finishing Touches on Sewage Effluents

There are now available methods of sewage treatment whereby almost any desired ordinary degree of treatment can be obtained; but for the extreme in treatment—BOD reduction to 8 or 10—there is still much to be desired. Developments in this line are needed. Perhaps, continuing the cycle back to old-time methods, which are being perfected and developed, the humble sand filter may be the answer.

Many considerations prevent the use of the sand filter as it was used 30 years ago; but a higher rate sand filter seems to be wholly possible. Taking an effluent from a trickling filter or from a really well-operated chemical coagulation plant, a well constructed and designed sand filter should be able to operate at the rate of 400,000 to 600,000 gallons per acre per day, and deliver an effluent within the ranges mentioned above.

No doubt there will have to be further developments in equipment for sand bed dosing and operation before the full measure of value can be obtained from such installations. Present apparatus for dosing could be improved; the frequency of application with these high rates probably needs more study. Most important of all is the matter of application to the surface of the bed so as to obtain an even distribution over the entire surface without erosion or washing of the sand. There is not much experience available on these phases of sand filter operation. Perhaps a rotary distributor may be devised that would meet these varying needs of application.

Salt Subgrade Stabilization in a Kansas County

By MALOY QUINN
County Engineer, Clay County, Kansas

Low cost and use of minimum of equipment and a maximum of labor, yet giving an excellent and easily maintained surface in a dry climate, salt stabilized subgrades have found approval in this Kansas County.

SALT subgrade stabilization has proven an economical worthwhile addition to Clay County's surfacing and work relief program. It has given us a not-too-hard-to-obtain aggregate and a low-cost stabilizing agent;and—even more desirable—it involved a minimum of equipment rental, making it an ideal work relief project.

We first became interested in salt stabilization because of the frequent necessity of resurfacing our light-surfaced roads, of which we have approximately 160 miles. For several years we have been constructing these, using 600 to 800 cu. yd. per mile of crushed stone and river gravel, and have had to come back in a couple of years and add another course to replace material lost by erosion and traffic. (We were not able to finance extensive oil mat work.) Not only was this too expensive but the surface was unsatisfactory.

My attention had been called to salt stabilization by articles in trade magazines and a representative of the Morton Salt Co., and the Board of County Commissioners and myself visited two stretches of road so stabilized, and were favorably impressed. The salt soil stabilized subgrade contemplated consists of a compacted course (I would recommend a minimum thickness of 3 inches) composed of materials such as gravel or crushed stone, mixed with a soil binder of fine sand, silt or clay, to which salt is added; giving a densely graded aggregate with earth binder, well compacted and moisture retaining. In some parts of the country such a mixture without the salt gives a very satisfactory surface, but in this section rainfall and moisture are not adequate to hold this mixture.

After the commissioners had authorized the construction of a salt stabilized subgrade, we prepared and presented to the Works Progress Administration a project covering four miles of highway, the aggregate to consist of crusher-run limestone, river bank silt, a good grade of clay, and salt. The limestone was crushed to a maximum size of 1½ inches straight crusher run, which gave us the following gradation in percentages retained:

Retained on 1½" 0%	Retained on No. 8....78%
Retained on 1" 11%	Retained on No. 14....82%
Retained on ¾".......21%	Retained on No. 28....86%
Retained on ⅜".......61%	Retained on No. 48....89%
Retained on No. 4....72%	Retained on No. 100....91%
	Retained on No. 200....92%

Our gradation, compared with the specifications recommended by the salt company, was light between the 28 and 100 mesh sieve, so we added river bank sand of the following gradation:

Retained on No. 14 mesh sieve............	2%
Retained on No. 28 mesh sieve............	4%
Retained on No. 60 mesh sieve............	60%
Retained on No. 100 mesh sieve............	89%
Retained on No. 200 mesh sieve............	94%

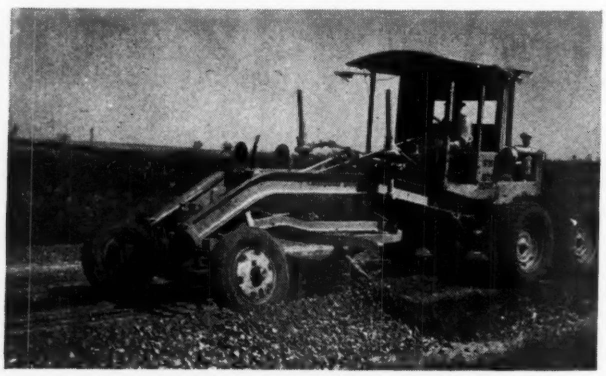
The clay used is what in our specifications is known as Group A-7 Red Clay having a plastic index of 26.7.

These were used in the proportion of 69.4% crusher-run limestone, 15.4% bank-run river sand and 15.2% clay. A total of 1,300 cubic yards per mile of the combined aggregate was used, giving a subgrade 22 ft. wide and 3 in. thick.

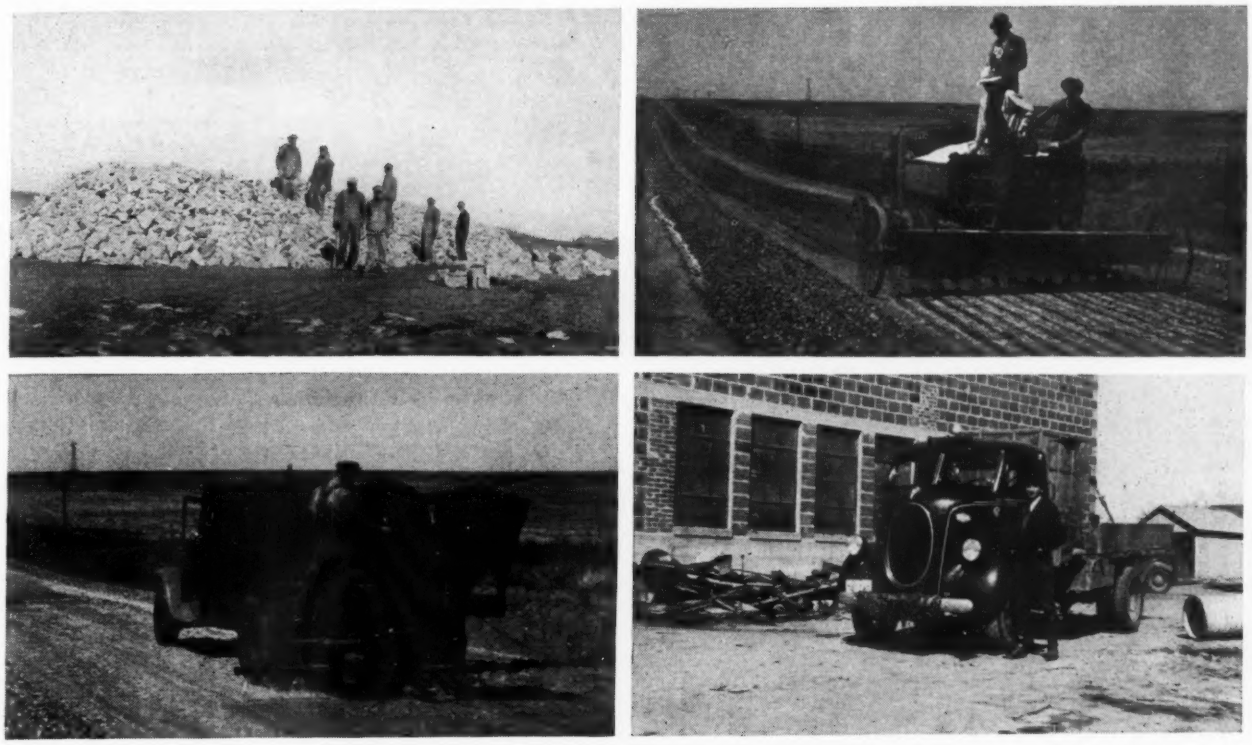
Our rock quarry was 2½ miles from the north end of this project, and our first operation in starting the project was quarrying, crushing, and delivering this rock in a windrow on the surface to be stabilized. Next we deposited the river sand on top of this windrow and placed the clay adjacent to it. To keep from losing the silt and clay by wind or rain action, we kept the windrow mixed by using a Caterpillar diesel maintainer at the end of each day's hauling. After all of the aggregate had been thoroughly mixed and windrowed, and the base cleaned, we were ready to apply the salt.

The specifications required the use of a total per mile of 12 tons of rock salt consisting of 98% pure sodium chloride soluble in water, conforming to the U. S. Standard screen size which is termed Kansas No. 7, which grades as follows:

Passing No. 4 mesh sieve..........	95%
Passing No. 10 mesh sieve..........	10% to 35%
Passing No. 30 mesh sieve..........	5%



Mixing aggregate on road



Above left, the rock-pile, and right, spreading salt on the road. Below, left, distributing the water from a bituminous distributor, and right, the new Mercury truck with the author beside it.

We used what is known as the dry method in manipulating this material. The salt was spread at the rate of 6 tons per mile dry on the cleaned base surface, using a farm seeder as our spreading agent, pulling it behind the truck and shoveling the salt into it. Then one-half of the mixed aggregate was spread evenly across and over the salt and thoroughly saturated with water (which was hauled by an oil distributor), 1.9 gallons of water per square yard per course being required to moisten the mixture sufficiently to give good compaction. The amount of water required was determined by the plastic index of the aggregate, using standard procedures.

To get compaction, we used as rolling agents a smooth-faced 5-ton roller pulled by a 1½-ton truck, and a four-dual-tired 1½ ton truck loaded with two yards of sand. After the first course had been thoroughly rolled and compacted, the remaining 6 tons of salt was spread over the rolled surface and the other half of the aggregate pulled over the top of the salt, moistened and rolled. We maintained the top course continuously during the rolling to give a smooth surface. With the equipment, two No. 10 Caterpillar diesel patrols, one 800 gallon oil distributor, one roller, and four trucks, we were able to complete one mile of manipulation per day.

On our third mile we had about one-half inch of rain in the morning after we had spread our first course and before we had it moistened and rolled. Our only out was to continue rolling and manipulating. When evening came we were sure that this mile would be a complete failure; however, the next morning a few trips over it with the maintainer and roller put it in ideal shape. At this writing I believe it to be the best mile of the four. We hope to have rain on all of our stabilization work this year.

The result obtained from this stabilization is a good, hard (and I really mean hard), smooth, dustless surface not requiring machine maintenance, ready for an armor coat wearing surface.

We had planned to place an armor coat of bituminous material on this surface last fall; however, weather conditions prevented us from doing this, and the stabilized base has been used as a wearing course for the past six months and has stood up remarkably well considering the dry weather we have experienced. We have lost some of the fines which were floated to the top in finishing because of the traffic; however, I believe this will improve the stability of the bituminous armor coat, inasmuch as the surface is much rougher than it was immediately after being completed and should give a better bond. There have been no pot holes or ruptures developed, and no maintenance.

As to the cost of this work, I am sure that over a period of four years it will not not exceed that of ordinary surfacing plus maintaining. The cost of aggregate averaged $2.74 per yard, the cost of manipulation (using W. P. A. rental rates as a basis) was $128.00 per mile, the cost of water $29.60, the cost of rolling was $52.00; a total average cost per mile of $3,671.60.

This spring we plan to add an armor coat of blotter-type bituminous surfacing, using approximately .5 gallon of R. C. asphalt. This will cost about $500 per mile.

On our new work coming up this summer, profiting by last year's experience, we plan not to use an aggregate larger than one inch. We believe as a compacting agent a sheeps-foot roller would be a valuable addition to the equipment used last year. We also plan to do the manipulation in either the fall or spring—the evaporation of moisture in the summer causes too great a loss.

We believe this type of construction to be economical because it furnishes an ideal work relief project and gives us a low-cost permanent surface forming the body of a pavement on which to place a wearing coat.

1. Laying water pipe—
a modern necessity

Operation and Maintena
Distribution Sy

Prepared by
W. A. Hardenbergh and Consulting Staff

Water works operation cannot be learned from books alone; nor solely from experience. Both are essential. To provide a basic text, available to all water works operators, the following material is presented in the hope that it will be a real assistance to the men in the field. Primarily it is intended to provide a foundation from which further education may be built up.—The Editors.

QUALITY, quantity, and cost are the most important factors in water supply. The first requisite is that the water must be safe, that is, it must contain nothing that may injure the health of the consumers. It must also be satisfactory as regards odor, taste, softness, color, turbidity, and mineral content. "The Operation of Water Treatment Plants" published in the April, 1938 issue of PUBLIC WORKS, presented data on these factors, and described the methods of operating the various treatment processes in order to obtain a safe and satisfactory water. Even though complete treatment may not be necessary, in most cases chlorination is desirable to insure the safety of the water, and taste and odor control to make it palatable.

Quantity

The quantity of water required depends on many local factors, which may be grouped under three principal heads—domestic use, industrial use and fire protection. In the average American city, the domestic and industrial consumption combined is about 100 gallons per person per day.

The *rate* of use of water varies greatly. Everyone knows, of course, that it will be less in the hours just after midnight than it will during the daytime. If there is not a considerable difference between the night and day use, an important leak is generally indicated. In summer months, as a rule, more water is used. In July and August, the use will be about 1¼ times the average; also, more water is used on Mondays, and sometimes on Saturdays; the most water is generally used in the morning hours from 7 o'clock on. Experience has shown that the use on the maximum day is about 1½ times the rate for the maximum month; and during the two or three hours of maximum use, the rate is about 1½ or 2 times the rate during the maximum day. Therefore pipes must be large enough to carry readily about three times the average use of water.

In addition to this, provision must be made for fire uses. In large cities, a distribution system that will supply enough water for domestic and industrial uses will generally be amply large for fire protection. But in the smaller communities, those having populations of less than 10,000 or 15,000, fire protection may require the use of much larger pipes than would be needed otherwise.

For instance, a community of 1,000 population will use about 100,000 gallons per day of water. The rate of use on the maximum day of the maximum month will not be over 15,000 gallons per hour, or 250 gallons per minute. For such a community, the National Board of Fire Underwriters requires that a fire-flow of 1,000 gpm per provided, or four times that required for ordinary use. For a community of 2,000 population, 1,500 gpm must be provided; and for a community of 4,000 2,000 gpm. Even in the latter case, the flow that must be provided for fire protection is twice as great as that required for domestic use.

Adequate fire protection also necessitates provision of a reservoir or tank with capacity sufficient to fight a possible fire. For communities of less than 2,000 population, there should be provided enough storage for a 5-hour fire flow, and for larger communities, a 10-hour fire flow.

Thus, on the basis of a community of 2,000 population, the water required for fire protection may amount to 1,500 gpm for 5 hours, or a total of 450,000 gallons. This amount, in addition to the water required for domestic use, should be available in reservoirs near at hand, from which two or more outlets are available. If the water is brought from a distant source, and nearby reservoirs will not supply the total amount required, other provision can be made. The requirements of the National Board of Fire Underwriters form a valuable guide in good practice, and a copy of these should be in every superintendent's office. Compliance with their standards will result in a marked saving in insurance costs.

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W. L. Savell
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Jeff Corydon
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James E. Gibson
R. D. Strayer
C. W. Stackhouse
W. P. Cox
Guy Northrop
J. E. O'Leary
J. B. McFarland
O. M. Anderson
Clint Inglee

Cost

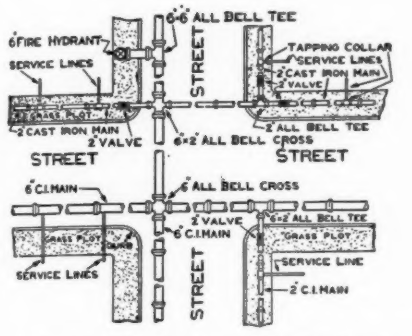
The income from water sales must pay as a rule, except through the sale of water; and the income from water sales must pay the salary of the superintendent and the wages of the laborers; the interest on bonds; the cost of necessary repairs, replacements and extensions; and the overhead costs of operation. Therefore, the superintendent should seek to increase water use, and thereby the income to the department, by selling as much water as the system will readily supply. Many of the costs connected with providing water

nt ance of Water Works

on Systems

do not vary with the amount; therefore the more water sold, the greater will be the net income.

The superintendent should study the needs of all large water users, both actual and potential, and should know what their requirements are, both as to quality and quantity. In regard to the latter, the fol-



2. How 2-inch pipe is used in the 2-main system

lowing factors may be important: The rate of usage; the time of day when the rate of usage is high or low; seasonal or other fluctuations in demand; and the required pressure, if abnormal.

Distribution System Pressures

Pressures in the distribution system should not be less than 30 pounds per square inch, nor more than 100 pounds. Pressures greater than 100 pounds require heavier pipes and more care in construction and maintenance, result in greater leakage losses, and may increase the cost of maintaining house piping and plumbing systems. Pressure below about 30 pounds will not give satisfactory service on the upper floors of buildings only 3 or 4 stories high. So far as fire protection is concerned, 60 to 80 pounds pressure is desirable if engines are not used; but most communities are now well provided with motor fire equipment, and it is more important for fire protection to have mains of ample size than it is to have high pressures.

Pressures in distribution systems should be measured at the time of greatest water use, and not at night or other times when the draft on the system is small.

Where there are no engines, the National Board of Fire Underwriters recommends a pressure at the fire nozzle of 75 pounds in well-built up areas; 60 pounds in less important districts; and 50 pounds in thinly built up areas. Where engines are available, 30 pounds is satisfactory under all conditions, if the mains are ample in size; and even 20 pounds in less important sections is sufficient.

Distribution System Layout

A distribution system should provide pipes capable of carrying the required amount of water within a reasonable distance of every building. Such "reasonable distance" generally should not be greater than 100 to 200 feet; and connections to the pipe must be possible without crossing the private property of others. A pipe is necesary in almost every street on which a house faces; in a few cases.

When a distribution system is composed of a main, with submains at right angles and street pipes connected with these, there are many dead-end pipes, in which water stands; also, if a submain is broken, a large area of the town will be without water. For these reasons, a system with a number of dead-end lines is considered undesirable. It is better practice, by connecting the dead ends and constructing circuits, to provide for circulation of the water through the system; which also improves the pressure in the street pipes.

By placing submains in about every third or fourth street, both ways, with smaller pipe in the intermediate streets connecting with the submains, a gridiron arrangement is effected which permits better service than is afforded by the dead end arrangement, and which provides continuous circulation of the water. In such an arrangement there may, and usually will, be a few remaining dead ends that cannot be eliminated economically. These should be provided with blow-off arrangements, either by a special connection or through hydrants.

THE ILLUSTRATIONS IN THIS ARTICLE

We wish to thank the following for illustrations used in the text herewith.

1. U. S. Pipe & Foundry Co.
2. McWane Cast Iron Pipe Co.
3. Cast Iron Pipe. Research Ass'n.
4. Central Foundry Co.
5. Johns-Manville.
6. McWane Cast Iron Pipe Co.
7. McWane Cast Iron Pipe Co.
8. Central Foundry Co.
9. Hydraulic Development Co.
10. Johns-Manville.
11. Johns-Manville.
12. Johns-Manville.
13. M. & H. Valve & Fittings Co.
14. Lock Joint Pipe Co.
15. Builders Iron Foundry
16. Layne & Bowler, Inc.
17. Mueller Co.
18. Ludlow Valve Co.
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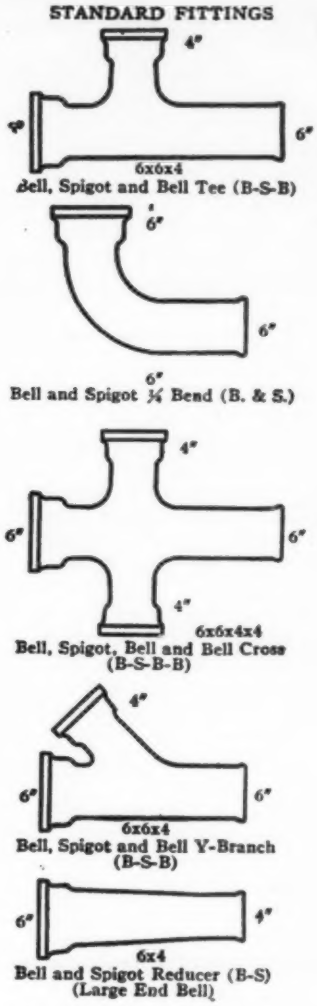
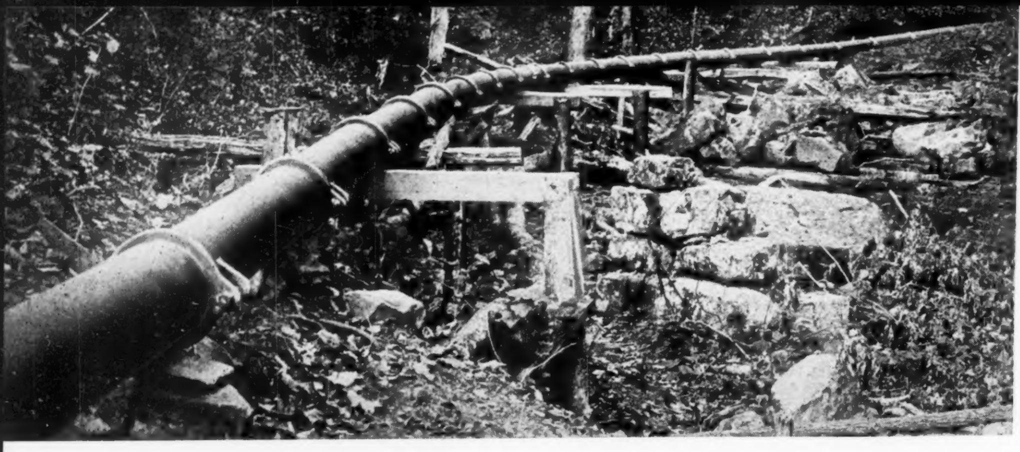


3. How to read fittings

Sizes of Pipe.—With one or two exceptions noted hereafter, mains should not be less than 6-inch; some communities do not lay mains smaller than 8-inch. While a 4-inch line will carry enough water to provide for the domestic needs of perhaps 1000 people, it will supply but one fire stream. Therefore, larger pipes are better, and it does not cost very much more to lay a 6-inch pipe than 4-inch, since costs of excavation and backfill are about the same.

A 2-inch pipe is excellent for the second pipe of a 2-main system. Several manufacturers make a 2-in. cast iron. Such pipe is also excellent for areas only slightly developed, as it can be taken up when the section becomes built up, and relaid elsewhere.

The demands of supply will fix the upper limits of size; but pipes larger than 48-inch are rarely laid in city streets because the damage resulting from a break would be too great. Also, two large mains should not be laid in the same street, for in case of a break in one, the other may be damaged also. And, in addition, in case of



4. This temporary line shows how pipe can be laid on a curve

a break, it may be difficult to determine which pipe is broken.

Mains or lines feeding a hydrant should be at least 6-inch, which ordinarily will carry enough water for two hose streams. An 8-inch line will carry nearly twice as much as a 6-inch. These statements refer to relatively long lines. A 6-inch hydrant connection only 30 or 40 feet long will deliver enough water for 4 fire streams if it draws from a pipe of ample size.

The use of one large pipe line in the midst of a network of smaller pipes is generally a waste and ineffective in improving conditions, unless this line is a direct feeder from a reservoir or another large main.

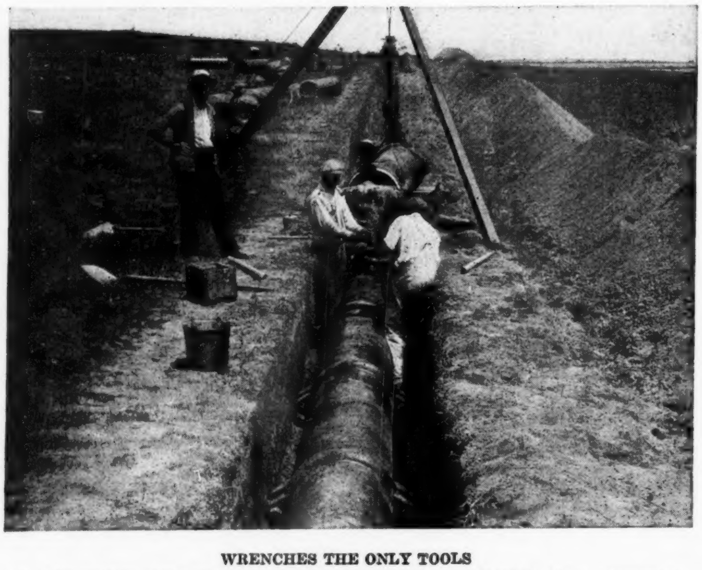
Location of Pipe in Street.—In main streets, the location of the pipe in the street will often depend on other subsurface structures. The area underneath a street surface is often crowded with sanitary and storm sewers, telephone conduits and other structures. The middle of the street is usually reserved for the sanitary sewer; the storm sewer is often placed above and to one side of the sanitary sewer. A good place for the water main is along one side of the street — the side on which the hydrants are located (see data hereafter on location of hydrants). Connections to houses on the other side of the street then become difficult and costly. For this reason, the two-main system has been adopted in many places, the principal main being placed at or near the curb on one side of the street, and a smaller main inside or near the curb on the other side of the street. Connections to all buildings are thus made easily without the necessity of cutting into the pavement, and repairs or other necessary work are also easier.

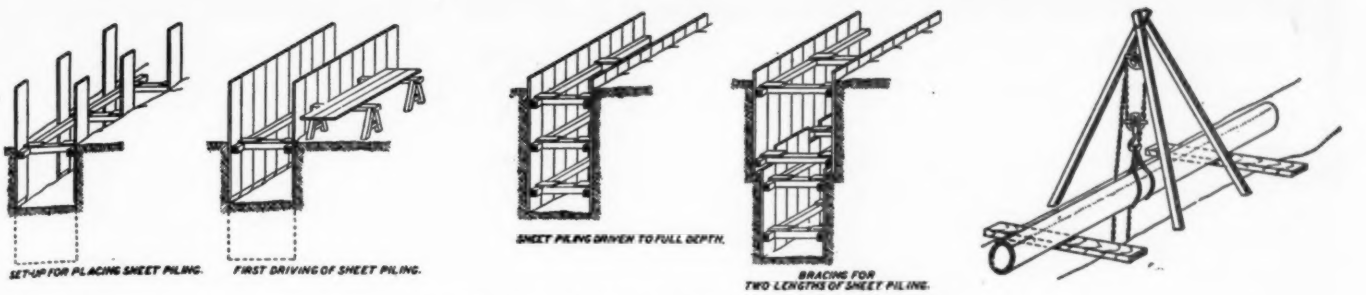
The cost of constructing two mains, as compared to one, may depend to a large extent on local conditions. In many cases it has proved to be cheaper in the end.

The size of the larger pipe, in the two-main system, depends on the requirements of the system as a whole. The other pipe can usually be smaller—2 inch cast iron is widely used. The two pipes should be connected at the end of each block or oftener.

Folwell suggests that the north side of east and west streets is preferable because the frost penetration is less. Also, he suggests that the same side of the street be used throughout. In any case, of course, water pipe should be laid below the frost line. In general, the depth that frost will penetrate is less in porous, well-drained soils, such as sand and gravel, than in clay or tight soils.

It is desirable, though apparently seldom done in smaller communities, to reference pipe so that it can be accurately located. Either it may be laid at a standard distance inside or outside of the curb, or the distance from the curb at each 100-ft. station may be recorded from some permanent and readily available point. This distance should be marked on the street maps indicating the size and general location of the pipe and the measurements for locating valves and fitting, which will be discussed later. Folwell[1] suggests placing the pipe a multiple of five feet from the property line. Thus, if the curb is 12 feet from the property line, a pipe outside





5. How to sheet a trench. At right, a derrick for handling pipe

the curb would be placed 15 feet from the property line. If this rule is followed throughout, pipe lines can be quickly located.

In extending a distribution system, or making changes suggested above, it is often necessary to insert T's, valves, etc. in existing pipe lines. By using valves or specials with spigot ends, and cutting out a piece of main of the same length, the special can be substituted and connected by means of mechanical joints. Or the piece can be cut from the spigot end of a pipe and a special designed for the purpose slipped into place. If it is desired to place these with the main full and under pressure, machines can be hired (or the work contracted) by which a connection of a new main to an existing one, each of almost any desired size, can be made in much the same way as a service tap; or machines are available for inserting a valve, tee or other special with the main under pressure.

Essentials in Laying Pipe

Laying pipe properly in the first place is the best method of reducing to a minimum necessary after maintenance. The following directions, which refer especially to cast iron pipe, are abstracted from the Handbook of Cast Iron Pipe[2]. The good practices illustrated, however, are applicable to all kinds of pipe.

Unloading Pipe.—When removing pipe from the cars or the trucks in which it which it is shipped, each length should be inspected for cracks. Damaged pipe should be called to the attention of the railroad or truck company representative and a notation made on the bill of lading so as to insure proper adjustment of the damage. In unloading, a derrick or crane is preferable for handling the pipe; otherwise it is permissible to roll it down skids, in which case a rope should be used to check the descent and keep the pipe under control. Be sure that the skids are strong enough and that the rope will hold it back, thereby safeguarding both the workmen and the pipe. Pipe should never be dropped onto hard ground or pavement; old automobile tires make a good pad.

In handling steel or other pipe protected with an outer bituminous coating, care should be taken to avoid damaging this. Use of a sling made of a belt of canvas, handled by a derrick, is recommended.

Delivering Pipe at the Work.—The above directions apply equally to unloading pipe from cars to trucks and from trucks to ground. Pipe should be placed at the work as follows: Bells facing the direction in which work is to proceed; each pipe should be as near as possible to the exact place where it will be laid; and it should be placed so as not be a hazard to traffic. Generally it should be as near as possible where the trench will be, and on the side opposite where the dirt will be piled. Care and forethought in placing the pipe will save much after work and annoyance.

Widths of Trench.—It is poor economy to have the trench too narrow for the workmen. Room is required for proper jointing, backfilling, etc.; this generally determines

6. Lowering pipe into trench

the trench width. Average widths that will be required for commonly used sizes of pipe are as follows:

Pipe Size	*Trench Widths*
6-inch	19 ins.
8-inch	22 ins.
10-inch	24 ins.
12-inch	26 ins.
14-inch	28 ins.
16-inch	30 ins.
18-inch	33 ins.
20-inch	35 ins.
24-inch	40 ins.

Jas. E. Gibson, Manager and Engineer, Charleston, S. C., Water Department, suggests that the above widths may often be reduced 2 ins.

Trenching.—The method used in digging the trench is immaterial, so far as this text is concerned. The bottom should conform very closely to the grade to which the pipe is to be laid, and the grade should be uniform, without numerous ups and downs. In rock excavation, rock should be removed to a depth 6 inches below the grade at which the pipe is to be laid. Proper grade should be established by covering the bottom with 6 inches of sand, clay or loam, sand being preferable. Rock should be removed so that it is not nearer than 6 inches to the pipe at any point. Stone should be removed from the trench bottom so that the pipe will not rest on a hard or non-uniform surface. The trench must be kept dry for the workmen, especially for making the joint. Centrifugal pumps are excellent for such work. Capacity rating is not the important factor in selecting the pump. Ability to handle dirty water (and some mud) as well as to pump faster than the seepage rate are important.

Bell Holes.—At each joint, bell holes should be dug so as to make proper jointing not only possible but easy. It is poor economy not to give the calker (when lead joints are used) ample room in which to swing his hammer properly. Bell holes should be 6 inches deeper than the bottom of the pipe bell; 12 to 20 inches wider than the remainder of the trench—6 to 10 inches on either side of the pipe; and about 4 ft. 6 ins. long. The face of the bell should be 3 ft. from one end of the 4½-ft. space that has been widened. Jas. E. Gibson believes bell holes can be narrower and shorter without loss of efficiency.

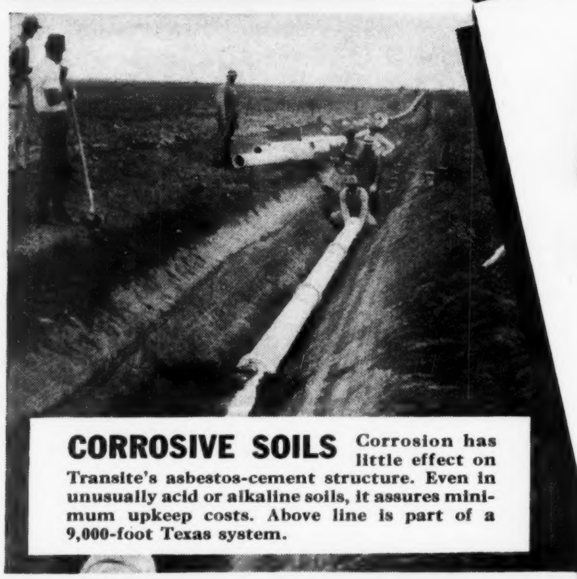
Blocking Pipe.—Cast iron pipe larger than 16-inch should be blocked. The primary purpose of blocks is to support and level the pipe during construction and while the backfill is settling. For 16-inch or 24-inch pipe, blocks should be 24 ins. long and about 2 ins. thick. They are placed on undisturbed earth, in slots, so that they project about ¾ inch above the trench bottom. Care should be taken that the slots are level so as to give support to the block over its entire length.One block or set of blocks should be placed just behind the bell, and another about 2ft. from the spigot. Blocking is not a substitute for proper preparation of the trench to get a firm and even bedding for the pipe (JEG).

Lowering the Pipe.—Pipe should not be dropped into the trench unless this has been padded with old automobile tires stacked sufficiently to prevent damage. Sizes up to 12-inch may be lowered by taking a turn around the pipe with a rope, standing on one end of the rope and paying out the other. Two men can handle smaller pipe; more will be required with large pipe. Sizes above 12-inch should be handled with a derrick. A 4-leg derrick with a hand-operated winch is excellent

INSTALLATION COSTS A simple, easily operated chain puller is the only tool needed for assembly of Simplex Couplings. Unskilled crews can lay Transite rapidly and economically, as fast as the trench is opened. Job shown here is in Washington State.

HANDLING COSTS Transite's long, light lengths keep handling costs low. Smaller trucks carry more footage; loading and unloading is faster, easier. More than 16,000 feet of Transite are used on this Pennsylvania line.

Which of These Problems Will You Meet Next?



CORROSIVE SOILS Corrosion has little effect on Transite's asbestos-cement structure. Even in unusually acid or alkaline soils, it assures minimum upkeep costs. Above line is part of a 9,000-foot Texas system.

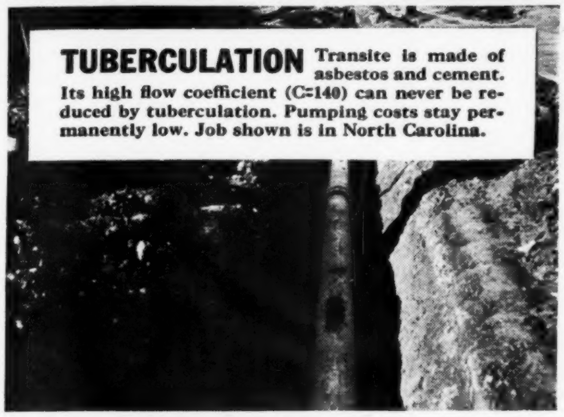
DEEP TRENCHES In deep trenches like the above, Transite's strength and durability protect against breakage. Over ten miles of Transite are used on this California system.

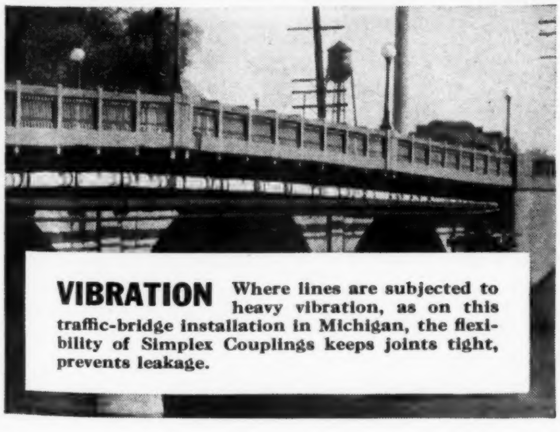
WIDE SWEEPS Flexibility of Simplex Couplings permits wide sweeps to be made with straight lengths of Transite. No special fittings are needed, joints stay tight. Above job in Maine.

ELECTROLYSIS Electric current from power or street-railway lines cannot damage Transite. It is inorganic, immune to electrolysis. This system is in Winnipeg, Canada.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE





GET SET FOR SAVINGS WITH TRANSITE!

SOONER OR LATER, you're going to run into one—probably several—of these conditions on your water systems. How *economically* you meet them depends largely on the pipe you specify. That's why you should have all the facts on J-M Transite Pipe.

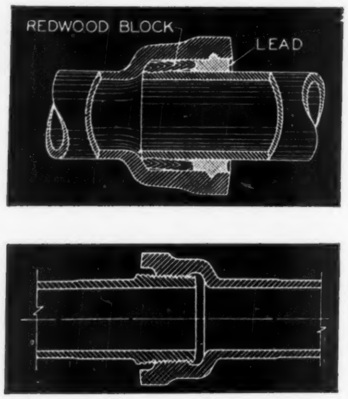
This asbestos-cement water carrier combines every advantage necessary for long, economical water-carrying service. Strong and durable, it is exceptionally resistant to soil corrosion, immune to electrolysis. Being non-metallic, Transite cannot tuberculate—its high delivery capacity (C = 140) can never be reduced by this costly economic evil. Bottle-tight Simplex Couplings eliminate joint leakage. And, because of its long lengths, light weight and speed of assembly, the installed cost of Transite Pipe is surprisingly low.

Hundreds of municipalities all over the country are keeping water-transportation costs to a minimum with J-M Transite Pipe, and more than 10 miles of this durable, asbestos-cement water carrier have been installed in the grounds of the New York World's Fair. For details on the 25-year service record back of J-M Transite Pipe, write for brochure TR-11A. And, for new ideas on efficient, economical sewerage systems, ask for the Transite Sewer Pipe brochure, TR-21A. Johns-Manville, 22 East 40th Street, New York, N. Y.

PIPE

An Asbestos Product

THE MODERN MATERIAL FOR WATER AND SEWER LINES



7. Above, McWane pre-calked joint. Below, the screw joint for smaller pipe

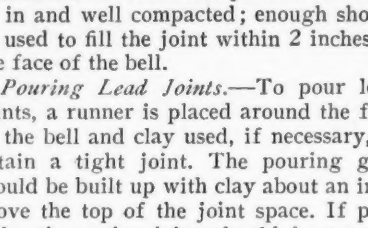
for medium sizes of pipe where the sections do not weigh more than 1½ or 2 tons. A 3-leg derrick tips easily and must be handled carefully. For larger sizes, power equipment is generally needed. See also instructions for unloading pipe.

Yarning.—Before entering the spigot into the bell, yarn should be wound around the spigot end and held in place as the spigot is entered in order to center it in the bell. Yarn should be cut a little longer than the circumference of the pipe so that the ends of each piece will overlap. If the spigot is not centered in the bell, the pipe should be raised or adjusted by lifting or with wedges, and additional yarn driven in to center it. Additional yarn is then driven in and well compacted; enough should be used to fill the joint within 2 inches of the face of the bell.

Pouring Lead Joints.—To pour lead joints, a runner is placed around the face of the bell and clay used, if necessary, to obtain a tight joint. The pouring gate should be built up with clay about an inch above the top of the joint space. If possible, the entire joint should be poured from one ladle of lead; this is usually possible with the medium and smaller pipe. As soon as the joint has cooled, the runner is removed.

Best practice in calking requires that each calking tool, from the smallest to the largest that will fit the joint space, should be used and that the joint be calked completely around with each tool.

Yarning Compound Joints.—Clean the bell and spigot of all dirt, oil, grease or hardened drops or ridges of pipe coating. Insert spigot into bell so as to give uniform joint space and see that end of spigot is solid against hub of bell. Pack with dry jute, preferably braided, free from oil or tar. Use two rings of jute and butt ends on opposite sides of pipe, not on top or bottom. The jute should be caulked in with a yarning hammer, sufficiently hard to leave a uniform depth of joint space 2½ inches deep.



8. The Universal Joint

Pouring Compound Joints. — After yarning thoroughly, clean joint before placing jointer. Wash jointer in clay water to prevent sticking. Place jointer and then place funnel over jointer, resting cutout section on bell. Clay around bottom of funnel. It is important to use these pouring funnels. Pour enough compound to fill completely both joint and funnel.

Remove jointer a few minutes after pouring but leave funnel until it is cool enough to be handled comfortably. Break gate or funnel off by tapping top of funnel towards the bell.

Removing Compound Joints. — Compound joints can be removed with a cutting out chisel. Burning out is undesirable.

(The above four paragraphs on compound joints were prepared by Guy Northrop, Hydraulic Development Corp.)

Mechanical Joints.—There are a large number of mechanical joints available. Most of the cast iron pipe manufacturers have their own special design of joint, and there are also other mechanical joints for connecting plain-end pipe. Most of these joints have the advantage of a certain degree of flexibility, which permits their use in locations and for types of work where rigid joints are difficult or impossible to use.

Universal Pipe.—Universal cast iron pipe is a standard pipe with a special joint. Lengths are 6 ft.; joints are machined iron to iron. The design of the joint and its accurate machining provides for the laying of the pipe around curves and permits contraction, expansion and deflection of the pipe without leakage. Lugs at each end are cast as an integral part of the pipe. The machined surfaces of the joints are brought together by tightening two bolts which are passed through the lugs. Great tension on the bolts is not required. A portion of the machined surface of the male end should be exposed with a properly made joint. No bell holes are required, and no caulking, yarning or pouring of lead. The only tools needed are ratchet wrenches. While of especial value for bridge crossing and subaqueous installation, the chief use for Universal pipe is in water distribution systems. A complete list of fittings is available.

Making Joints in Wet Ditches.—When using lead joints, the water must be kept pumped out of the bell holes and the joint and the yarn must be dry. If the yarn becomes wet due to water in the pipe or to flooding of the trench, a small amount of kerosene may be poured into the joint just prior to pouring the lead. Molten lead in a wet joint will generate steam and blow the runner out of place; and may even blow molten lead over the workers.

Lead wool can be used, but considerable care is necessary under such conditions to get a tight joint. Some or all of the lead substitutes that have been mentioned can be used to pour wet joints without danger. A small hole should be left at the bottom of the runner so that the joint material can force the water out, and as soon as the joint material begins to flow through the hole, this should be plugged.

9. Pouring a compound joint

Other Kinds of Pipes

This text refers primarily to distribution systems. Lock Joint concrete pipe and steel pipe, which are of greatest use in supply lines are not, therefore, discussed.

Handling and Laying Transite Pipe.[3]—Transite pipes are handled in much the same manner as already described for metal pipes, except that being considerably lighter in weight, handling is simplified. Trench widths recommended by Johns-Manville is outside diameter of the pipe plus 12 ins.

A special coupling and rubber ring are used to connect the lengths of pipe. A class 50 coupling must be used for class 50 pipe, since both pipe and couplings are carefully machined; a class 100 coupling has excessive clearance on a class 50 pipe.

The use of blocks is recommended for supporting the pipe properly under the backfill. These blocks should be placed at the points marked on the pipe at the factory; these points are 32½ ins. from the ends on 13-ft. long pipe; and 25 inches from the ends on 10-ft. long pipe. The procedure already given for tamping fill around the pipe should be followed in backfilling.

Pipe up to 6-in., class 50, can be handled by one man by hand; two men can handle similarly 10-in., class 50 or 8-in. class 100; two men with ropes can lower into the trench 16-inch class 50, 12-inch class 100, or 10-inch class 150. Four men with ropes can handle up to 24-inch class

50, 18-inch class 100 or 16-inch class 150.

The Simplex coupling is used for jointing. This consists of a sleeve and two rubber rings. In making the joint, the sleeve is placed over the end of the pipe and slid to the rear of the machined portion. One rubber ring is then placed on the pipe, rolled back and forth to straighten it, if necessary, and placed finally at the point marked at the factory. The second ring is then placed as near the end of the pipe as possible. The pipes to be joined are then lined up, the space between the pipes being not more than ¼ inch and preferably less. A hydraulic or lever type coupling puller is then hooked over the pipe and the coupling is pulled into place. This completes the making of the joint, except that the final location of the rubber ring is checked with a metal gauge inserted into the joint.

A certain amount of deflection is possible with Transite pipe and Simplex couplings; the recommended amount depends on the working pressure. A wider trench is needed, as the pipe is lined up straight and deflected after jointing is completed. Expansion and contraction that may occur in the line is taken up by the joints.

Transite pipe can be cut with a carpenter's six-point rip handsaw. A mitre box insures a straight cut; or a line can be marked around the pipe.

Fittings of cast iron or other materials are used, Transite pipe being furnished only in straight lengths. These fittings include oversize-bell cast iron, cast iron bell and spigot adaptors and reducing adaptors. Joint compounds, lead or cement are used for connecting the pipe to the cast iron bells.

Service connections are made by drilling and tapping into the pipe wall and inserting standard corporation cocks. The ¾-inch size is most generally used.

Testing Lines and Completing the Job

Testing the Pipe Line.—No pipe line should be covered until it has been tested for leaks. At least the usual pressure that the line will carry should be used, and preferably a greater pressure. When lead substitutes are used, the test should be deferred for 48 hours, the pipe meanwhile being filled with water.

In filling the line with water, provision must be made for releasing the air in the line. If air relief valves have been installed at all high points, opening a hydrant or valve at the upper end of the line will permit the line to fill. Water should be admitted to the line rather slowly.

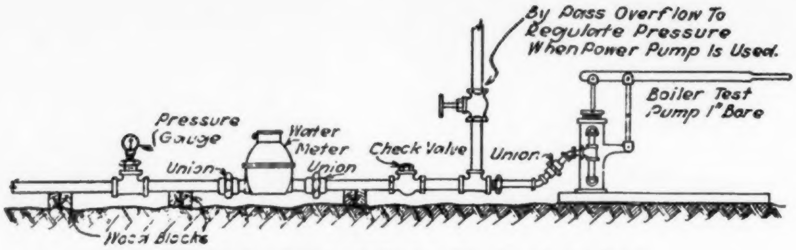
If main pressure is to be used for testing, the valve between the new and old sections may be closed, a tap made in both lines, and a ⅝" meter inserted between goosenecks. If desired a "gulper" can be installed to measure very small flows. By recording the flow through the meter, the leakage can be determined for any desired period, as 24 hours.

In case a higher pressure is used for testing, a pump is connected to the already filled line; a small meter is so placed that water from the pump passes through it. When the pressure in the line is at the desired point, the meter is read. Thereafter, the amount of water required to keep the pressure up to the desired point is registered.

While the line is undergoing the test, it should be inspected carefully. Each length of pipe should be checked and the condition of each joint noted. Those joints that are leaking should be recalked, or, if necessary replaced. In the case of lead substitutes, additional time may be allowed for the joint to take up, since joints that, at first, appear to leak badly may tighten satisfactorily.

Permissible Amount of Leakage.—The leakage that can be permitted in newly constructed lines is generally placed at about 100 gallons per day per mile of line for each inch of diameter. Thus a 10-inch line might have 1000 gallons per day leakage per mile of line; a 16-inch line 1600 gallons. For instance, 1500 ft. of 8-inch main on a 1-hour test should show a leakage of not more than 9.4 gals. Best results are obtained when the workmen know the line is to be tested.

Backfilling.—Many pipe failures are caused by careless or improper backfilling. Good backfilling should provide support for the pipe; this means that selected earth, free from stones should be packed under the pipe and up the sides to the center. Earth free for stones, clods or frozen particles should be used to cover the pipe at least 6 inches. Where the pipe is laid in streets, greater care is necessary. The vibration under heavy traffic and the loads from wheels on unpaved streets tend to place an additional strain on the pipe. Extra care should be taken that no stones are in contact with the pipe, and that the trench is properly backfilled.



10. A typical set-up for testing a pipe line for leakage

An additional reason for careful backfilling is to prevent damage to the replaced pavement from subsequent settling of the trench. Probably best compacting of backfill is obtained by using pneumatic tampers operated by a portable compressor. In "water tamping" (soaking the backfill), be careful in clay soil not to make it too soft; if it is, it may take days or weeks to become solid.

Replacing the Pavement. — The first step is to be sure the trench is properly compacted. This is best done by placing the moistened, but not wet, earth in 6-inch layers in the trench and compacting with power tampers or hand rammers. The compacted material must give adequate support to the pavement. With other types, the same general method is used. When replacing bituminous surfaces, aggregate and bitumen may be mixed in a concrete mixer and tamped in place. The street department will usually have bituminous material suitable for the work[4].

Lines Through Swamps or Fills.—In soft swamps, the support for the pipe line may be totally inadequate and the resultant settling may open joints or even set up stresses that will break the pipe. These are the more serious because of the difficulty of repair in such areas, and also because it is practically impossible to find leaks that develop in the line. Therefore, in case of any doubt about the bearing quality of the foundation material, some support should be provided for the line. This support may take the form of timber grills or supports, piling or concrete piers, as local conditions indicate.

In "made ground," proper support may be lacking, or there may be a possibility or probability of such settlement as will heavily stress or even break the line. Concrete piers reaching down to a firm foundation will be desirable in such cases. The spacing of these piers will depend upon the depth of cover of the pipe.

Lines in other Unfavorable Conditions. —In rock, the trench should be cut 6 inches deeper than the pipe is to be laid, and a cushion of sand or dirt placed to support the pipe. The procedure in backfilling around and for 6" above the pipe has already been described. Serious consideration should be given to the question of backfilling the rest of the trench with the excavated and broken stone, or of hauling in dirt. If the stone fragments are used, future excavation will be difficult and costly, and the possibility of damage to the pipe must be considered; also dirt placed on top of such stone may continue to settle into it for years to come.

On sidehill areas, the possibility of slides or slips of the earth should be considered. If it is necessary to place a line in a doubtful location of this sort, careful study should be given to soil conditions and a combination of surface and subsurface drainage to remove the danger of such slips[5]. If the potential slide is very shallow, stakes may hold it[6].

In laying lines through salt marshes, cinder fills, slag piles, garbage dumps, or areas affected by undesirable wastes, careful study must be given to the problem of preventing corrosion. Generally manufacturers of the various kinds of pipe that are used for mains can give sound advice on methods of protecting against corrosion under these conditions.

Cutting Pipe.—Pipe cutting machines are made for cutting cast iron pipe, but pipe is also cut with hammers and chisels. The cutting machines are made in several sizes; one of them will cut 4-inch, 6-inch and 8-inch pipe; the second size 10-inch to 16-inch, inclusive; and other sizes up to 48-inch.

A 3-wheel cutter will easily cut 2-in. cast iron pipe. Cold chisels also can be used to cut small pipe. A mark should be made around the pipe, straight and at exact right angles to the axis of the pipe. Then a shallow cut is made in the pipe along this line, using a hammer and a chisel, and this is deepened by going around the pipe several times until the piece breaks off. In cutting the pipe should be placed on a block of wood or supported on firm ground. Too heavy blows from large hammers may crack the pipe. If, for any reason the piece is not cut off square, it should not be used for the particular purpose intended, but may be chipped off smooth and used for a place requiring a shorter length. A comparatively smooth edge can be obtained by resting the uneven end of the pipe that has been cut off on a hard edge, as a piece of railroad iron, and chipping with a hammer. Goggles to protect the eyes should be worn.

Cutting Cement-Lined Pipe.—Cement-lined pipes are not more difficult to cut than other cast iron pipes and, in general, the same equipment and methods may be used —chisels and hammers, and wheel cutters. A machine cutter is preferable on almost any pipe, as it will not damage any kind of enamels or linings.

Removing Lead Joints.—There are machines for cutting out lead joints; these are usually made in the same range of sizes as the pipe cutters—4 to 8-inch; 10 to 16-inch, etc. Leaded joints are exceedingly difficult to pull apart. A blow torch or oxy-acetylene burner can be used to melt out the lead.

Disinfecting Newly Laid Lines. — Water mains should be protected against contamination while they are being installed; dirt and other material should be removed before laying. Before being placed in service, every section of pipe should be flushed out and then chlorinated, using a dose sufficient to give 40 to 50 p.p.m. of residual chlorine. In some places, the flushing out is omitted, and a small amount of bleaching powder, HTH or Perchloron is placed at the time of laying in each pipe, or in the case of small pipe, in each third or fourth length[7].

When using bleaching powder, 25% available chlorine, the following amounts are required for each 100 feet of pipe: 4-inch, 1½ ounces; 6-inch, 3½ ounces; 8-inch, 6 ounces; 10-inch, 10 ounces; 12-inch, 15 ounces; 16-inch, 36 ounces. When using HTH or Perchloron, 40% as much is sufficient; AWWA Standards suggest 1 pound (70% available chlorine) for each 1680 gallons of pipe capacity to be treated.

When the bleach is placed in the pipes as they are laid, the line is filled slowly with the water and allowed to stand for 3 to 12 hours; it is then flushed thoroughly. When the chlorine is not placed in the pipes, it should be made into a solution, and added to the line as it is being filled with water. Orthotolidine tests should be made on the water. These should show a strong red color.

When liquid chlorine is used, a corporation cock is inserted in the old line near the point of connection with the new line, and a special stuffing box is inserted and connected to a chlorine cylinder with a silver or copper tube. The stuffing box and tube can be obtained from manufacturers of chlorinators; also special chlorinators for this purpose are available, and are preferable.

After the connection is made, the new line is flushed out; after it has drained, water is then turned into it slowly, and chlorine gas from the cylinder is turned into the main. Water pressure must be below 30 pounds or the chlorine may not flow into the main.

Orthotolidine tests should be made on the water as it comes out of the valve or hydrant at the far end of the line. When a strong red color is obtained by the test, allow the line to fill, shut off the chlorine, and the valve admitting water to the new line. Allow to stand for 3 to 12 hours, and flush thoroughly. If there is no valve or hydrant at the lower end of the line, a testing plug fitted with a stop-cock can be placed in the end of the pipe line, to permit the discharge of air as the line is filled with water, and also to permit taking samples of water for making orthotolidine tests.

Supporting Bends and Other Fittings. —In lines that carry a considerable pressure, a sharp bend results in a thrust tending to pull the line apart. In such places, it is customary to place a support. This may consist of poured concrete which encases all or part of the bend, or some other bulwark to take the thrust.[3] A rough estimation of the thrust that will occur can be

made by multiplying the area of the pipe in inches by the pressure in pounds per square inch. Some manufacturers provide a special reinforced construction for use in such places.

Expansion of Pipe Lines.—Where, for any reason, considerable expansion or contraction of the pipe may occur—as where the pipe is exposed for a considerable distance—either expansion joints or anchorages should be provided. The coefficient of expansion of cast iron is 0.0000062. To determine the expansion, multiply this figure by the length in feet times the temperature variation. For 1000 feet of pipe, and a variation in temperature from 30° below zero to 120° above zero, the change in length from coldest to hottest periods will be .0000062 x 1000 x 150 + 0.93 feet, or about 11 inches. In laying cast iron pipe in cold weather, leave a small space between the spigot and the bottom of the bell to allow for expansion.[2]

Anchorages may also be constructed to resist motion caused by expansion or contraction. Where the amount of stress that will be set up by such motions is considerable, special consideration by someone experienced in this work is most desirable.

Anchorages for Steep Slopes.—When pipe lines are laid up or down a steep hillside, concrete anchorages, firmly set in place, should be provided to counteract any tendency of the pipe to slide downhill in the trench due to the weight of the pipe.

Causes of Failure in Pipe Lines

No matter what the kind of pipe used in a distribution system, some failures will occur sooner or later, and leaks will develope. These failures must be repaired quickly, for the supply of water to a community is vital.

Failures will depend largely upon the care in laying the pipe; but also on the pressure in the pipe system and on other factors. A study of breaks in cast iron water pipes has shown that the number of failures—and also of leaks—are a fair index to the quality of construction work; and this is true of all kinds of pipes.

Settlement of Supporting Earth.—Washouts and wet weather slips and slides may leave pipe lines unsupported, especially when they are laid on steep hillsides or on stream or roadside banks. Settlement may also occur if leaking joints wash out or cause subsidence of earth under the lines.

In city streets there are numerous pipes and conduits, excavations to which are being made frequently. This work may undermine water pipes, or leave them improperly supported, so that after-settlement will cause breaks. When excavations are to be made near water lines for any purpose this should be reported to the water department so that a watch can be maintained over the work and, if necessary, provisions made that will prevent damage to the water system pipes. In most cities, permits are required for cuts in the streets; and when such permits are granted, the water department should be notified.

Joint Failures.—Poor construction may cause joint failures, though slight ground movements or vibrations may also cause joint trouble even in perfectly constructed lines. Testing of the line in the trench under a pressure greater than service pressure will disclose nearly all improperly made joints and thus greatly reduce after troubles from this source.

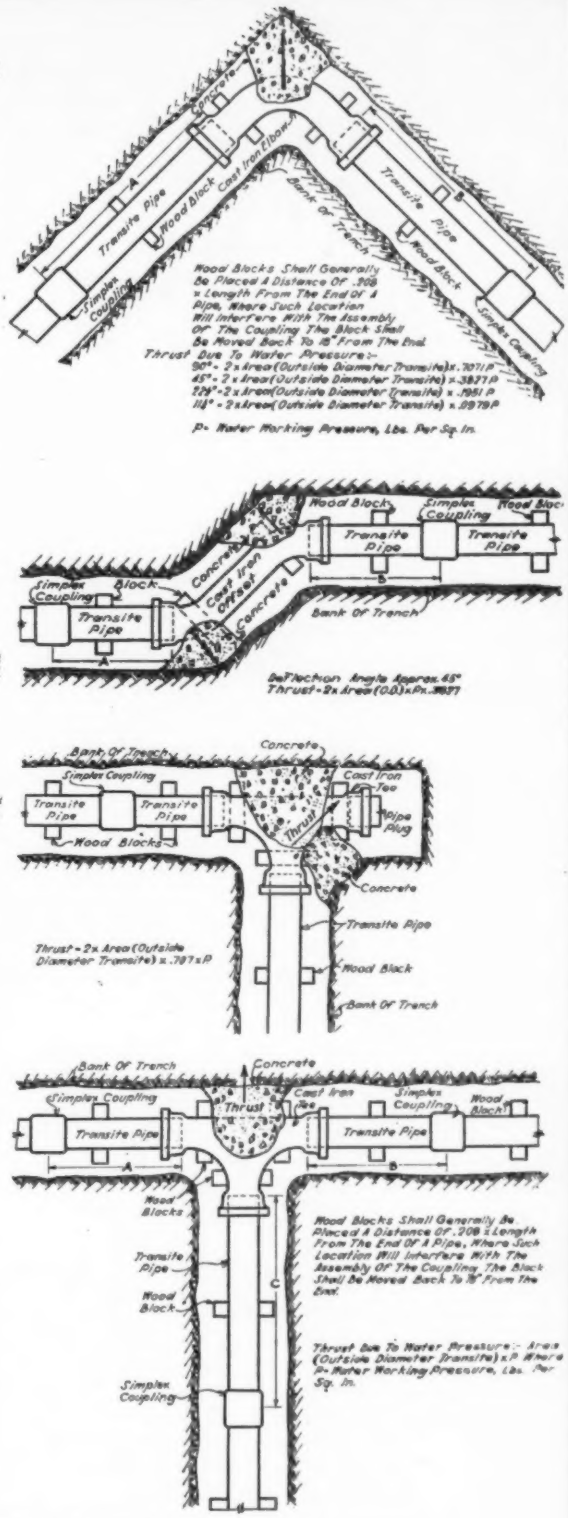
External Blows.—Unless accurate records showing the exact location of pipe lines are available, construction work may damage them. Pile drivers; power shovels in street grading or other work; sewer or conduit excavation; and blasting are the more common sources of trouble. If a record is kept that shows the exact location of the line and its elevation in respect to the curb or other permanent fixed point, much of this kind of damage can be prevented.

Contact With Rock or Stones.—If a pipe rests on a large stone, a break some time in the future is likely. For this reason, careful bedding of the pipe on dirt is important. A stone in contact with the pipe, as by careless backfilling, may also cause a break. According to the Cast Iron Pipe Research Association, the natural pulsation of the water in the line results in strains in the pipe wall at the point of such contact.

Vibration.—A pipe laid under railroad tracks is subject to considerable vibration; also a pipe laid along a main highway subject to heavy truck traffic, especially if the foundation soil is not stable; and a pipe line across a bridge. Such vibrations cause severe strains in both pipe and joints. Probably the best way to avoid possible damage to a pipe that must be laid under railroad tracks is to place the pipe inside a corrugated metal or concrete conduit. A conduit larger than the pipe should be used, and the two should not be fastened together, nor should the space around the pipe be backfilled. Resting the pipe on saddles of rubber or even soft wood will help to reduce the vibration. Dresser has a casing bushing to seal the space between the pipe and the casing. In soft, quaking soil, James E. Gibson believes a casing may be an added hazard, as it may settle and place a concentrated load on the pipe.

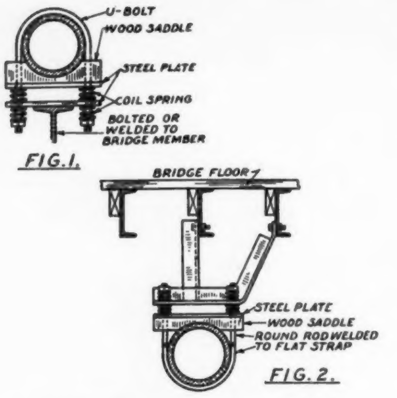
Water Hammer.—Water hammer occurs when the flow of water in a pipe, especially a long pipe, is suddenly stopped. It is most frequently caused by rapid closing of valves or the quick stoppage of a pump. If a pressure gage is placed in a line near a valve through which water is flowing, and this valve is then quickly closed, the gage will show a greatly increased pressure, followed after a short time by a below normal pressure. Water hammer may be severe enough to burst pipes. To prevent such damage, valves and also hydrants should be opened and closed slowly.

Injury Before Laying.—Proper procedure in handling pipe while unloading, hauling and placing at the site of the work has already been discussed. Sometimes a very small crack or other damage is caused in handling. For this reason careful inspection of the pipe (including hammer testing it) before accepting it, and again before laying, is desirable. It is better to discard a damaged pipe than have to dig it up and replace it later.



11. The above shows some of the common methods of supporting pipe at bends and tees

Freezing.—Freezing of the water in a pipe usually breaks it. Adequate cover is needed, the amount depending on the probable minimum temperature, the size of the pipe, the velocity of flow in it and the kind of soil. A large pipe resists freezing better than a small one; if there is a steady flow in the pipe it is less likely to freeze; a cover of dry, porous material, as well-drained sand or gravel, protects against freezing better than wet clay.



12. How to fasten pipe to bridges

Exposed pipes, as on bridge crossings, are usually protected by an insulating cover; and in addition a continuous flow should be maintained in them. The writer does not know of any reliable formula for the amount of protection required under such conditions, and suggests that manufacturers of insulating materials be consulted.

Excessive Pressure.—Breaks may be more frequent with high pressures, since the stress on the pipe is greater; joint leaks will also be more troublesome; and house plumbing will require more maintenance. Other things being equal, a pressure of 120 pounds per square inch in a distribution system will require more maintenance and repairs than a pressure of 60 or 70 pounds.

Making Repairs.—Split sleeves are available by means of which cracked pipes can be repaired; also devices for making leaky joints tight; and many other items of a similar nature.

Locating Leaks

In every water distribution system, and probably in every pipe line, some water is lost by leakage. The amount lost varies greatly. The efficient superintendent will use every means to keep this loss at a minimum. If the lines have been laid with reasonable care, the leakage should probably not be more than 3000 to 5000 gallons per day per mile of line, though much depends on the pressure. A leakage loss materially greater than this will usually justify a search for important leaks. A frequent check should be made of water sold and water delivered to determine unaccounted for water; and if this is excessive, or if it increases without apparent reason, search should be made for the cause.

The procedure in locating leaks depends to a large extent on whether the leaks are in supply lines, elements of the distribution system or house service lines. Various aids are available to help in locating leaks. These include the pitometer for measuring the flow in a pipe; and various leak detectors, all of which operate on the basis that water escaping through a leak makes a noise.

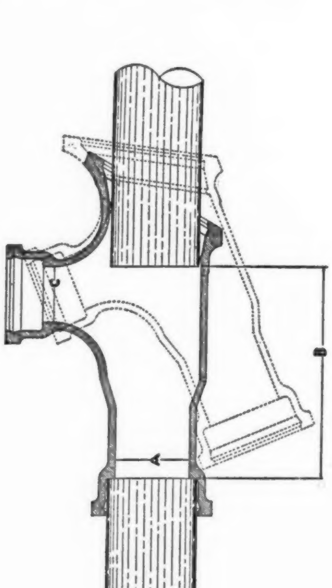
Leak Detectors. — The aquaphone, which is somewhat similar to a stethoscope, is the simplest of these detectors. When it is placed in contact with a hydrant, service box or pipe, the noise made by the escaping water is transmitted to the ear. It is not necessary to uncover the main; an iron bar can be driven down to contact with the pipe and the aquaphone placed against the bar. In at least one device, an amplifier, battery and ear receivers are used.

The Pitometer.—This is an essential instrument for detecting leakage by means of measuring flow through the lines. A 1-inch corporation cock is tapped into the main and two pitometer orifices inserted. These are connected to a glass U-tube, and the rate of flow in the main can be read directly; or, by means of attachments, a continuous record of flow for a day or other period can be made.

Procedure in Finding Leaks.—To be effective, any search designed to locate leaks in a system must be well planned and carefully and thoroughly carried out. Sporadic attempts may result in the location of some leaks—possibly of most large ones—but may miss others equally important by their number.

The first step is to determine, if possible, the "unaccounted for" water. The amount of water that is supplied daily should be known accurately, for every system should have some device for measuring and recording it. If this amount is checked against the water that has been sold through meters for any month (or other period), plus other known uses (estimated if necessary), a good idea will be obtained of the loss. Not all communities are 100% metered, but the superintendent should have a comprehensive knowledge of water use by unmetered customers and should be able to make a fairly accurate estimate of the consumption and of water taken for public uses.

With this estimate as to water loss at hand, the next step should be to determine whether leaks are in the supply line or in the distribution system. The supply line may be checked first. This main is tapped at the inlet or supply end and pitometer tubes inserted and the flow read. This may be compared with the flow as registered by any other device, but no matter how measured, the flow should also be determined by the pitometer. This is necessary because measurements at other points will have to be made with the pitometer, and the same equipment should be used for all of them.



13. How the cutting-in tee is used

After the measurement of flow at the intake end of the line has been made, another should be made where the first branch or lateral leaves it. The difference in flow shows the loss in this line. It is better to have two pitometers, which have been tested against each other, so that the two readings can be made at the same time. Otherwise, care must be taken that successive readings be made when water use conditions are the same.

This process is then repeated for the entire length of the supply line. If an important loss of water is discovered between any two testing points, careful inspection of the line for surface indications of leakage and continued testing at closer intervals will soon disclose the general location of the leak. The exact location can then be found by leak finders or other method.

Leaks in Distribution System.—The detection of leaks in a distribution system is more difficult because there is often a multiplicity of pipes, all more or less interconnected. The most common method of locating such leaks is to close all but one of the valves around a selected area so that water flows to this area through only a single pipe. This flow is measured, and if found to be excessive or suspiciously large the area is divided into smaller districts and each of these tested in a similar manner, until the leak is located. Pressure readings on hydrants may be sufficient for the preliminary work.

In determining what an excessive or suspiciously large flow is, judgment and a knowledge of local conditions are needed. The consumption of water is usually much greater during the day than during the night. Therefore a comparison of day and night flows would be important, and a night flow that is one-half or two-thirds that during the day would ordinarily indicate an important leak. But possible night use by industries, hospitals, etc., should be considered.

Also, a consideration of the number of people that draw water from a given area, and the use by factories and industries should allow a reasonable estimate of what the consumption should be from any given portion of the city.

If meters are not available for measuring the flow into the area, the pitometer may be tapped into the feeding pipe and the flow read in this way. Or all the mains entering the entire area can be closed and the area fed through a hose that draws water from a hydrant outside the area and feeds it into another inside it, a meter being inserted in the hose line.

Leaks are not always due to broken mains or leaking joints. Excessive consumption may be caused by leaking service pipes or poorly maintained plumbing. If a district, when tested, indicates a

large water use, but not a serious leak, a house-to-house inspection will often pay. This inspection should be thorough. It should include fixtures, uses and a check on services. The check on services may include a late-at-night test to determine if water is going through the service. By testing at the meter box (if outside), at the cutoff or other similar place, flowing water can be heard by means of an aquaphone. A private service line flowing steadily after midnight is usually evidence of waste or leakage.

Loss of water due to waste is as objectionable as if due to leaks if it is not metered; and is often more difficult to stop. The best solution generally is metering.

Leakage and waste surveys often disclose other defects, as valves that have been forgotten, and have remained unintentionally either open or closed. Such surveys should probably include a check on every tap that is recorded as having been made. It is not unusual to find some of these taps abandoned but still flowing steadily. Such a check can usually be made adequately with an aquaphone, and without the necessity of digging up doubtful taps.

Many other advantages accrue from regular attention to accounting for excessive flows, these frequently including better pressure and the deferring of the need for new and larger mains or for a more ample source of water supply.

Flow in Pipe Lines

The rate of flow in pipe lines, aside from head and size of pipe, depends largely upon such factors as encrustation and tuberculation of the interior of the pipe, the accumulation of sediment, air locks, and valves that are only partly open.

Encrustation. — Deposits or growths may form on the inside of the pipes, reducing the area available for carying water. Such deposits or growths may be due to any of a number of causes, but the most common is an excess of calcium carbonate in the water. This matter of encrustation is closely related to corrosion and red water troubles. Both of these have been discussed fully.[8] Prevention of encrustation can be accomplished easily by chemical control of the water to provide the proper pH and alkalinity relation.

Tuberculation.—The formation of tubercules in pipe lines is closely associated with the quality of the water. The soft waters of New England and the Atlantic seaboard are favorable for the formation of tubercules, while the hard waters of the Central West are unfavorable for their formation. The tubercules are a combination of iron and iron consuming bacteria which usually form on a small pinnacle of iron protruding above the average surface of the pipe. Most of the iron consumed in forming the body of the tubercle is absorbed from the water and only a small portion is taken from the wall of the pipe. The formation may be prevented by the use of various forms of lining or by treating properly the water.

Growths. — Certain animal and vegetable growths may occur on the inside of the pipe. The growths that are most common are known as pipe moss (paludicella) and pipe sponge (spongilla). The latter does not cling so tightly to the pipe, and often can be removed by flushing; in fact, sheets of it may strip off the pipe surface and be carried to the service pipes. Iron in solution in the water is believed to be essential for the sponge growth and control of the chemical balance of the water will usually control both it and the moss. The latter is not affected by flushing and can be removed only by scraping.

Sediment.—Where the intake of a pipe line is not well protected against the entrance of mud, dirt and other flood-carried materials, sediment may accumulate in the lines, especially at low points. Provision for preventing access of flood waters without previous settlement should be the first step. Proper flushing will remove most of the sediment.

Red mud may also reduce pipe capacity. This is due to clay or iron in the water, and forms around the entire circumference of the pipe, reducing the effective area of the pipe and also increasing the friction. Flushing or cleaning is effective in improving red mud conditions.

Air Locks.—All water contains more or less air in the form of very small bubbles. As the water passes through the pipe, some of these bubbles separate out and collect at high points in the line. If not released, the entrapped air finally collects in

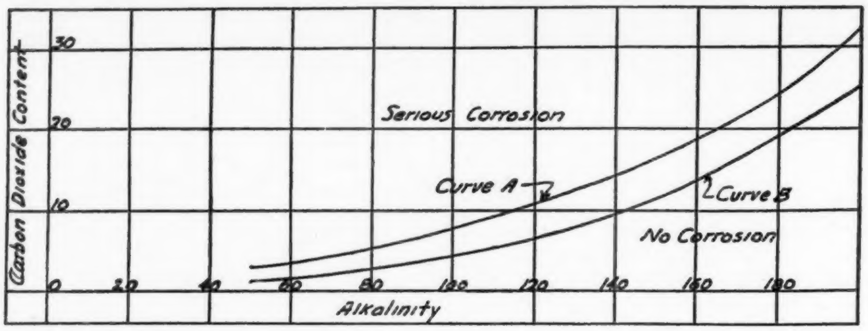
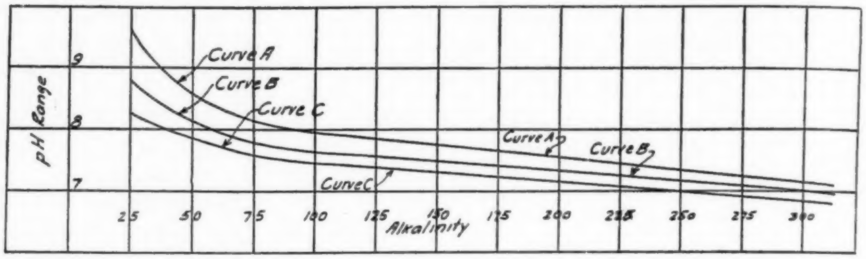


Fig. A, at left, shows relation between corrosion, alkalinity and CO_2. Values for CO_2 and alkalinity falling below curve B do not cause corrosion. Between the two curves there is approximate calcium carbonate equilibrium. Above curve A serious corrosion is indicated. Fig. B, below, shows relation between pH, alkalinity and corrosion. If pH and alkalinity values fall above curve A, calcium carbonate will be deposited. If above curve B, but below A, a calcium carbonate equilibrium is maintained. Between curves B and C, corrosion is negligible. Below curve C, corrosion will occur.



enough quantity that the flow is greatly reduced or may even be stopped entirely.

Therefore, in laying a line, provision must be made at each high point to release this air. On some small lines, taps are made at these high points and a nipple and valve inserted. A manhole or other device is constructed to permit a man to reach and open the valve and release the air.

Automatic air relief valves are much more effective. These operate by means of a float to release the air, but close when all the air has escaped. These should be placed in a manhole at all high points.

Experience has shown that many lines, especially those constructed in small communities without proper engineering supervision, are operating at only a fraction of their capacity due to air locks. A survey to locate high spots and the installation of the necessary relief valves is the solution.

Planning.—An early step for any water works system should be the mapping of the entire distribution system. The map should show (1) the layout of pipe lines; (2) the sizes of pipe; (3) the location of all valves, hydrants and other appurtenances; (4) the age of the pipes composing each line; (5) the type of area served, as heavy, light or medium draft; and (6) pressures in each area. With such a map at hand, various methods of computation now available for determining flows in distribution systems can be utilized to redesign the system to meet existing and probable future needs.

Other Distribution System Problems

Encrustation, tuberculation and related troubles have been considered in connection with their effect in reducing pipe line capacities. Corrosion and red water problems are also caused by improper chemical balance of the water. Correction is possible, usually without excessive cost either in construction or operation.

Corrosion. — The corrosion of iron, brass, copper or lead pipe occurs because of the solution of the metal by the water. It depends upon (1) the solubility of the metal and (2) the character of the water. The first factor can be disregarded here since normally the superintendent must work with what he already has in place in his distribution system. Also, it is possible to control the character of the water so as to make the first factor of relatively small importance.

Corrosion will be indicated to the consumer by "red water" troubles from iron and sometimes by green water from brass or copper piping.

Corrective Measures.—It is the relationship between the alkalinity and the pH of the water that determines corrosion (and also encrustation, previously discussed). If the alkalinity is too low, as compared to the pH, corrosion and red water will occur. If free carbon dioxide is present in waters of low alkalinity, corrosion will occur, also. These relationships have been fully discussed and described[8]. The charts herewith show, for instance, that a CO_2 content of 5 ppm will cause corrosion if the alkalinity is less than about 75 ppm.; and that with a pH of 7.5, the alkalinity must be at least 75 ppm to prevent corrosion.

Aeration or treatment with lime or soda ash are simple and effective methods for the control of corrosion and the elimination of complaints due to red or green water, iron stains on laundry, etc. These methods of treatment were quite fully described in "How to Operate Water Treatment Plants."[9]

Many electric appliances are being used in homes, some of which require grounding. Grounding on water pipes sometimes results in setting up electrical currents which damage or interfere with water works appliances. For instance, at least one city has found it desirable to use a hard rubber connection at house meters, this connection breaking the travel of any current along the pipe. A wire connection around the meter permits the grounding to operate.

Too much weight has generally been placed on the possibility of trouble being caused by such groundings. It is believed that most cases of green water from copper services, etc., are due to a corrosive water, rather than to electrical connections. Simple chemical tests for pH, alkalinity and CO_2 will quickly show if the water is at fault by reference to the accompanying charts.

Electrolysis. — Return or stray electric currents may damage or destroy mains and service connections. The extent of damage that is being done in any distribution system is usually known to the superintendent through the routine work and repairs necessarily carried on to maintain the system, though it is not always easy to differentiate between corrosion and electrolysis.

In addition to cooperation with the power companies, certain preventive and remedial measures can be applied. New lines may be constructed with insulated joints, using some of the lead substitutes and placing a wooden ring in the bell to prevent contact between the pipe sections. However, if such joints are inserted as repair units at intervals in old lines, greater damage may be caused by the current where it leaves the pipe to pass around such a joint.

New lines, in areas that give trouble from electrolysis, should be built with all joints non-conducting and located as far as possible from street car tracks and other conductors as telephone cables. Proper maintenance of street car tracks is most important where these exist, and electrolysis is best controlled by cooperative effort.

An insulating coating, if perfect, affords protection; if imperfect, it may concentrate damage at a few points and the pipe may suffer greater damage than if uncoated.

There is much information on this subject in the proceedings of the New England and American Water Works Associations. In general, where electrolysis exists as a serious problem it should be given special study on the basis of local conditions.

Miscellaneous Distribution Problems

Laying Water and Sewer Pipes in Same Trench.—This practice is not widely followed. Usually it is objectionable from the viewpoint of health protection. While the water pipe is normally under pressure and the sewer line is not, events may occur that will reverse these conditions, as when a sewer is plugged or flooded, and a broken water main elsewhere results in emptying

the water line, even creating a negative pressure in the higher parts. Also, a broken or flooded sewer may contaminate the soil, and in making repairs to the water line later, contamination may enter the water pipe. Also careless filling of the trench may cause the water main to settle with later possible breakage of the pipe.

In general, it is desirable to so locate water pipes in reference to sewers, cesspools, manholes and other sources of dangerous contamination that any possibility of infection of the water is reduced to the absolute minimum.

Thawing Frozen Pipes. — Frozen pipes are thawed in place by steam or electricity, or by uncovering and thawing with torches or by other means. If the pipe is broken by the freezing, it will have to be dug out and the broken section replaced.

For thawing by electricity, current can be taken from a power cable, if one is nearby, through transformers. Or the current can be generated on the spot for which purpose special machines are obtainable.

Cross Connections. — Many industries have their own source of water supply to furnish all or part of the water needed. Also, to provide for supplying their needs in case their own supply fails, connections are usually made to the public water supply.

The private supply may be intended only for industrial use and may be of poor sanitary quality, actually dangerous to use. When there are physical connections between this system and the public water supply, there is always the possibility that some of the dangerous water may pass into the public mains and cause disease. State health departments have prepared regulations covering cross-connections. Superintendents should, by careful and frequent inspections, determine what industries have their own supplies and should ask the the cooperation of the State Health Department in inspection, checking and regulation so as to prevent any contamination of the public water supply.

Metering

The use of meters for measuring the amount of water used by consumers is general. In many American cities practically every water user is metered. As a result, wastage is decreased and each user pays for the exact amount of water consumed, and costs can be allocated accordingly. To account accurately for the use of water, all main supplies must be metered as well as all services. On mains, Venturi meters are commonly used; on services, disc or similar meters. Comparisons between records by Venturi and domestic meters yields much valuable information.

Venturi Meters.—The Venturi Meter consists of a short section of pipe having a reduced diameter as compared to the remainder of the line and attached indicating, recording and registering apparatus. While the constriction, or reduced area section, causes only a very small loss of head in the line, the decreased pressure set up in the constricted section permits a very accurate measurement of the flow of water. Meters of this type are used on pipes from 2 ins. to more than 17 ft. in size, but have their greatest field of use in measuring and recording flows in supply lines. Many devices for registering rate of flow, total flow, etc., are available, and these can be connected by means of remote control apparatus to record flows anywhere, even in the office of the water department; also to control operation of pumps, etc.

Disc Meters—This type is used for measuring the water supplied through $1\frac{1}{4}$-inch or smaller pipes, though some communities use them also on larger lines. Meters of this type should not be too large, as they then under-register the amount of water used. A $\frac{5}{8}$-inch meter will serve 5 or 6 families; a $\frac{3}{4}$-inch meter up to 10 families; a 1-inch meter up to 15 or 18 families. In general, the meter should be smaller than the service pipe.

In order to determine the size of meter required, in case there is doubt, a Meter Master may be installed for a few days to determine the rate and amount of actual usage.

Compound Meters.—Compound meters are designed to measure accurately both large and small flows. They consist of a large meter, a small meter on a by-pass, and a device for directing the flow through the meter that is required by the volume of flow. The large meter is usually of the velocity or turbine type; the small meter of the disc type. Compound meters are placed on lines where the flow at times is too small for registration by a line-sized meter.

Velocity Meters.—The term "velocity meter" is used here to designate that type of meter in which a vaned wheel inserted in the pipe is rotated by the water passing through the line. The rotation of the wheel

14. Laying a concrete supply line

operates a gear train which indicates the amount of water that has passed. Such meters can be used only where the velocity in the pipe does not fall below about $1\frac{1}{2}$ feet per second. Lesser velocities may register inaccurately or not at all, in the case of very low flows.

Where to Set Meters.—It is preferable to set meters at curbs, but in cold climates, basement setting may be necessary. Considerations include[12]: Outside settings should be used where climate and soil conditions are favorable because the meter is always available to the reader, and readings are made more quickly; all water entering the consumer's pipe is metered, and leaks in service pipe are apt to be repaired more promptly; and meters are generally safer from freezing, tampering, mechanical injury and hot water damage. Inside settings should be used where the winter weather is so severe that, to prevent freezing, service lines must be 5 feet or more deep; where snows are so deep and frequent as to interfere materially with reading of the meters; and where piping conditions make an outside setting impractical or costly.

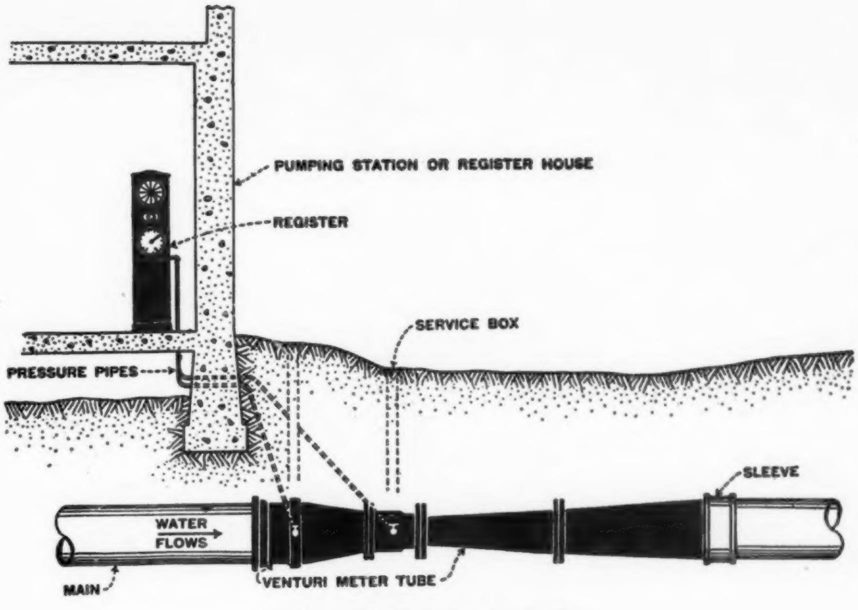
Making an Outside Setting.—The installation should afford protection for the meter and insure against accidents to pedestrians; that is, the meter box and cover should not project enough to stumble over, and the cover should fit closely and firmly enough so that if stepped on it will not permit an accident. Skimping on depth of installation or size of box may result in freezing; a margin of a few inches safety factor may save trouble and expense. An 18 or 20-inch tile or other meter housing is desirable; depth will depend on climatic conditions.

Inside Settings. — Piping conditions will usually determine inside settings. A vertical run of piping is often desirable, but it is preferable to have the meters installed horizontally with the dial up, as experience indicates that in this position they are more sensitive to small flows. A number of devices are available for permitting horizontal settings.

Precautions in Setting.—The spuds or

ends for making connections should be kept covered to exclude dust and dirt, until it is ready to be connected. When using joint compounds, as red or white lead, apply this only to the exterior threads, so that none of it can be forced into the meter. It is better not to use lead, if it can be avoided. The words "in" and "out" are cast on the spuds to show which way to set the meter. Before coupling the meter in place, the pipes should be flushed out carefully to remove dirt, lead, particles of iron, etc. A pipe nipple of the proper length can be inserted in the meter space for flushing.

Meter Accessories. — There are many accessories for meters, among them the "gulper" which is used when flows are very small. At such low flows, meters register too low or not at all. The "gulper" accumulates small flows into larger flows of short duration through the meter. Protection against cold weather is obtained by a "mitten," which is a flexible jacket of wire mesh or expanded metal; this is slipped around the meter and the space filled with rock wool.



15. How the Venturi meter works

Testing Water Meters. — Meter accuracy is expressed in percentages fast or slow. A meter that registers only 95 gallons on 100 gallons flow through it is 5% slow. A meter that registers 102 gallons on 100 gallons flow through it is 2% fast. Most meters, when inaccurate, under register, resulting in a loss of revenue.

Meters are usually tested by running water through them, weighing or measuring the water and comparing this volume with the reading of the meter. Testing is generally done in the shop, but test devices for field use are available. These are usually furnished in either 1 cubic foot or 10 gallons capacity. All other flows in the house are stopped and the water run through a section of hose or from a sill cock and the flow compared with the meter reading. The test tank need not be set perfectly level.

Procedure in testing is outlined as follows[12]: 1. Insert the meter in the tester, making a water tight connection. 2. Flush out the meter with a large flow to remove air from the meter and line; 10 gals. per minute or more is desirable. 3. Bring the test hand of the meter to a distinct mark by stopping the flow of water, or by turning the dial. 4. Run a test at the rate of 10 to 15 gallons per minute (for a ⅝-inch meter) for 3 to 5 minutes, allowing 50

16. Water plants deserve good housing, attractive and harmonious with the surroundings. This building of the Paducah Division of the Camden, N. J., water department houses Layne and Bowler pumps.

gallons or 10 cubic feet to pass through the meter. Note and record the result on both the meter and the tank. 5. Run a test at 1 to 2 gallons per minute, running 10 gallons or 1 cubic foot. Note and record the results. (In steps 4 and 5, more water than the amount mentioned may be run.) 6. Run a test at ¼ gallon per minute, running at least 5 gals. or ½ cubic foot. Note and record result.

Devices are available for testing a number of meters at the same time and with the same flow of water. Automatic calculating scales, which show directly the percentage of inaccuracy are also available. A single testing outfit will handle several sizes of meters, or ⅝, ¾, 1 and 1½-inch. Larger meters can usually be tested by using a section of a hose.

Inspection and Repair. — Meters are read monthly or quarterly, at which times their condition is noted. After a meter has been tested, if found inaccurate, it is dissembled and cleaned thoroughly, preferably with soap and water. Acids or cleaning compounds are undesirable. Worn or imperfect parts are replaced to make the meter accurate. The use of change gears alone to make a meter read accurately is doubtful, since a meter which needs change gears is often or usually in need of other repairs also.

Valves

The types of valves commonly used in waterworks systems are gate, check, balanced and pressure reducing or regulating. The purpose of the gate valve is to stop or control the flow of water. Check valves permit flow in only one direction. Balanced valves are stop valves that are designed for easy opening and closing under high pressures. Pressure-regulating valves are used to limit the pressure in one pipe or system to a maximum less than that which does or may exist in a pipe to which it is connected.

Gate Valves. — These are the primary type of valve for use in pipe lines and distribution systems. They are made by a large number of manufacturers.

Check Valves. — Check valves are designed to permit flow in one direction only, closing if the flow starts to reverse. They are used in many places about a pumping plant, and for some purposes in distribution systems.

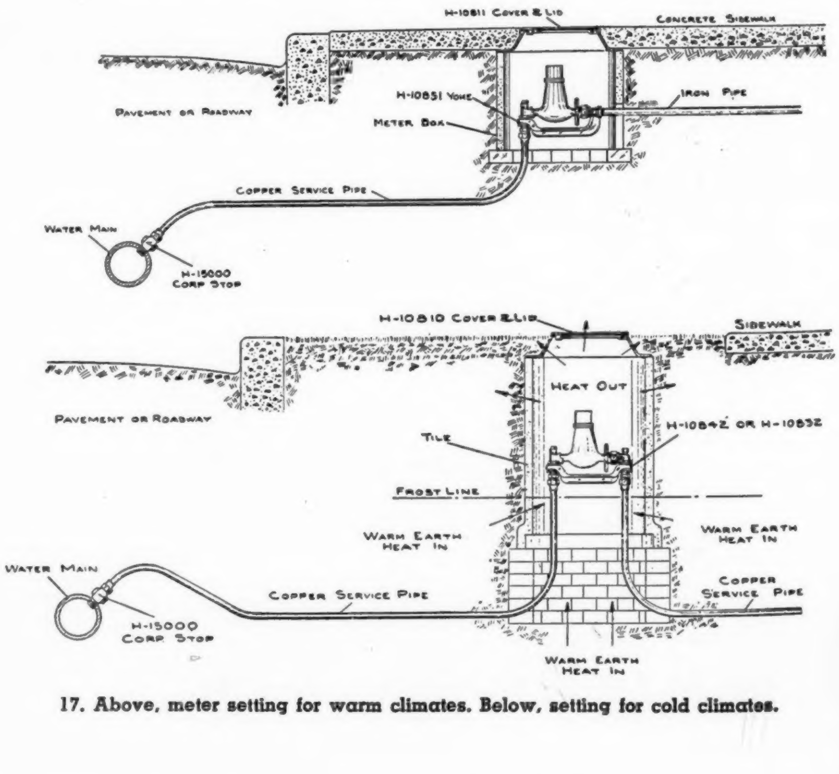
For protection against back-water pollution, several firms make a check valve to meet specifications prepared by the Associated Factory Mutual Fire Insurance Companies and accepted by most water departments and health boards. The main features of these are great care in construction details, the use of materials that will give the least possible wear or corrosion, and accessibility for inspection and cleaning. To increase the assurance of operation of the check, it is generally required that two of these valves be connected in series. See illustration on page 40.

Balanced Valves. — Balanced valves are those in which, by causing the water to enter or leave the valve in two or more opposite directions, the pressures and reactions balance each other.

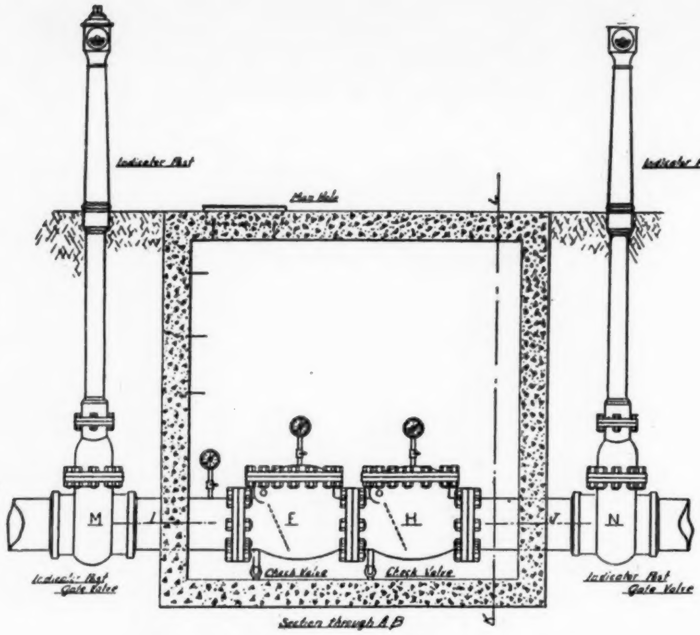
Pressure Regulating. — Satisfactory pressures in both high and low areas, without separate distribution systems, are possible by means of pressure-regulating valves, provided the necessary pressure drop is not too great. Ordinarily these will maintain pressures with a variation of not more than 5 lbs.; they should not be balanced so closely that every minor pressure fluctuation causes them to operate. They cannot be used where the flow alternates in direction. Frequent inspections are desirable, though operation is entirely automatic.

Placing Valves. — Street valves must be accessible for turning on and off; and with large valves, at least, it is necessary that the entire valve be accessible for servicing, inspection and repair. For the former purpose only, valve boxes are used; for the latter purpose, vaults or manholes.

Since valves are placed at various depths, valve boxes are made in two or more pieces which telescope so as to give adjustable length. There are two general types—in one the upper part screws onto the lower, permitting adjusting of the combined length; in the other the upper part simply fits loosely over the lower, being held at the proper height by a flange which is set in the surrounding



17. Above, meter setting for warm climates. Below, setting for cold climates.



18. Factory mutual double check valve setting

earth; or the flange may be omitted and entire reliance placed on the pavement for holding the top in place. Where the valve is unusually deep, a third extension piece may be used.

Where to Place Valves.—It is the general practice to use too few valves. The governing rule is to place valves so that no pipe more than two blocks, and in important areas one block, long that may be cut out will interfere with service in the remainder of the distribution system. Therefore, valves should be placed on three sides of a cross; on all mains and submains at intervals not greater than 500 ft. in high value districts and 800 ft. elsewhere; and on supply lines at intervals, depending on local conditions, of about 1500 feet. Such a comprehensive use of valves permits absolute control of flow in the distribution system and allows necessary repairs to be made without inconveniencing any large area, and without interference with fire protection.

On a cross, 3 valves are ordinarily required; at a T, 2 valves. Generally these will be placed on the smaller pipes. For instance where a 12-inch line enters a T, and a 10-inch and an 8-inch go out of the T, valves are needed only on the 10-inch and 8-inch.

Locating and Referencing. — Every valve in the system should be referenced to permanent objects so that it can be found readily, even when covered with snow. On supply lines, valves should be indicated by a letter or number on the profile and plan; the exact-location in reference to permanent objects should then be shown on a larger scale map. In such cases, both directions and distances are desirable; directions may be to the nearest degree or even 5 degrees; distances should be to feet and tenths.

In the distribution system, a separate sheet of the pipe map is usually provided for each block to show the detail location and layout of the system. Distances from 3 permanent fixed points are sufficient to locate valves or other fittings, the distances being given to feet and tenths.

It is good practice to locate valves uniformly—that is, always in line with the curb or with the property line. This assists materially in quickly locating them, as when snow is on the ground and records are not immediately available.

The requirements of the National Board of Fire Underwriters form a valuable guide for good practice in installation.

Sizes of Valves Required. — In the average water distribution system there are many sizes of pipe. If valves are provided for each size of pipe, the number of spare parts and of extra valves that must be kept in stock is considerable. This can be reduced by selecting a few sizes for use with all pipe sizes. Thus valves may be used as follows; for 6-inch pipe a 6-inch valve; for 8-inch and 10-inch pipe, an 8-inch valve; for 12-inch and 16-inch pipe, a 12-inch valve; and for 20-inch, 24-inch and 30-inch pipes, a 20-inch valve. Thus four sizes of valves will serve all pipe up to and including 30-inch. Where the valve is smaller than the pipe, long reducers should be placed on each side of the valve. The use of smaller valves is possible because the hydraulic losses involved are small, and as the cost of valves increases rapidly with the size, a considerable saving in cost may be obtained.

Records.—Full records should be kept of every valve that is installed. In addition to location, which has already been discussed, the records should include (1) size (2) date set (3) make (4) record of all markings on valve (5) dates inspected (6) number of turns to open or close (7) whether right hand or left hand (8) date and nature of repairs made.

Since records are worn out, lost or destroyed by fire or accident, duplicate sets should ordinarily be maintained, preferably in separate buildings.

Installing Valves.—Proper care in installation will reduce after troubles. Pipe threads (on steel pipe) that are cut too long may screw into the valve so far as to damage the valve seats or discs. Chips of iron, dirt or sand, if permitted to get into a valve may also damage the seats or discs so that the valve will never be tight. When handling or connecting a valve, it should be closed. Compound for insuring tight joints should be placed on the pipe threads, not on the valve threads, lest it be pushed into the valve seat. When using flanged connections, do not attempt to pull the valve and pipe together by the pull of tightening the bolts. Avoid sags in pipe lines that put a strain on the valve.

Valves should be set on soft earth so that trucks running over the tops of valve boxes will not cause breakage by shock or vibration. Unless sound reasons require otherwise, the valve should be set truly vertical.[10]

Operation and Maintenance of Valves

None but properly qualified employees of the water department should be permitted to operate valves. Inspections of a thorough nature should be made periodically preferably twice a year — in the spring and in the fall. During inspection the valve should be operated. The inspector should carry with him a copy of the record regarding each valve and should check the size and make; he should also fully open and fully close the valve, checking the number of turns required against the record. Evidence of leakage through the stuffing box should be noted.

If the valve does not open or close readily or fully, the attempt should be reported several times without using such force as may damage the valve. If the valve will not close all the way, it should be closed as far as possible and then opened about one turn and left for a few minutes. If it cannot be made to work properly, it must be replaced.

Particular attention should be paid to being sure the valve is kept open or closed, as is intended for normal use. It is not unusual to find valves closed, with resulting extra load on other lines and poor pressure and service in the area. This often results from installing a valve which opens or closes by turning in an opposite direction to other valves in the system. A standard opening direction should be adopted for each community, and followed rigidly. Valves that do not correspond to this standard should be clearly marked, as by painting red or the use of a clearly individual hand wheel.

Cleaning, Lubrication and Repair.—Mud and debris in the valve box should be removed. The valve should be lubricated at the time of each inspection. The packing may leak, in which case it should be renewed or the stuffing box tightened. Organic fats in the lubricant used sometimes cause corrosion. Petroleum-base lubricants and graphite have been found satisfactory.

A burlap bag that has been soaked in

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19. Accurate locating will be needed to find readily the vital points in this connection

waste oil is sometimes placed over the gears and operating mechanism to protect these.

How to Order Valves.—In ordering valves it is necessary to specify (1) type of valve; (2) size; (3) kind of ends, as double-hub, double-spigot, double flange, etc.; (4) if flange, size and spacing of bolt holes; (5) what valve will be used for; (6) pressure; (7) materials, as iron or bronze mounted; (8) direction of opening, as right or left, clockwise or counter-clockwise; (9) kind, as double or single disc; (10) position of valve axis; (11) kind of gear, as spur or bevel; (12) spindle rising or stationary.

The direction of opening should be the same as other valves in service unless there is a special reason for change. Most valves open left or counter-clockwise.

Hydrants

The primary purpose of a hydrant is to supply water for putting out fires. When a fire occurs, the instant use of a hydrant is needed badly. Therefore special provisions and precautions should be taken (1) to have hydrants so placed that they afford ample fire protection; (2) to have ample pressure and capacity of water available; and (3) to have the hydrant in good working shape.

Location.—The National Board of Fire Underwriters has prepared definite recommendations for spacing and location of hydrants. In general, hydrants should be placed at or near street intersections, and where the blocks are long, at intermediate points. The Fire Underwriters recommendations are for 200-ft. spacing where fire flow of 5000 gals. per minute is required, and 300 feet if the required fire flow is only 1000 gals. per minute. Hydrants are normally placed 18 inches or more back from the curb line; at intersections, the hydrant is generally placed on the street of least traffic; but not directly in front of a serious fire hazard.

Capacity and Delivery.—The capacity of standard hydrants that comply with the specifications of the Underwriters or of the American Water Works Association is ample. The amount of water that they will deliver actually depends upon the size and condition of the mains, the pressure in them and the size of the hydrant connection; and these factors are the important ones. From time to time every hydrant should be tested for delivery. A special study should be made of those that are found deficient and such changes or improvements made in the distribution system as will bring the hydrant delivery up to standard.

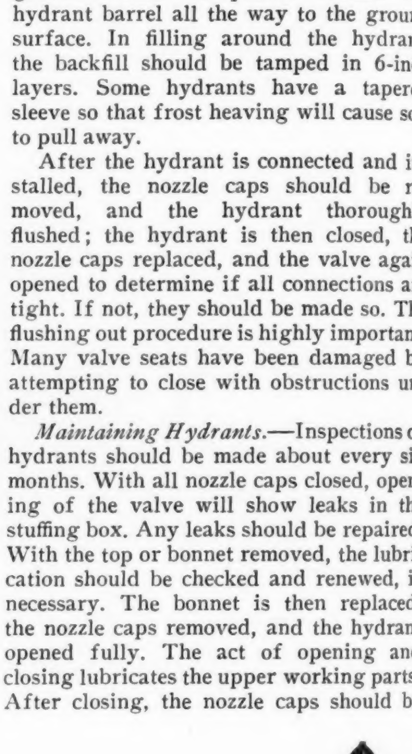
Marking Hydrant Capacity. — For painting, A.W.W.A., N.E.W.W.A. and National Fire Protection Ass'n recommend that tops and nozzle caps be green for 1000 or more gpm. capacity; orange for those of 500-1000 gpm., and red for those of less than 500 gpm. Some hydrants have a place provided on the bonnet for stamping main size, pressure, capacity, and other data.

Installing Hydrants.—Be sure that the hydrant is vertical. The bottom of the hydrant should be set on a firm object—a flat stone, concrete, or compacted broken stone. Gravel or broken stone should be placed under and around the base, to provide a sump to care for drainage from the barrel after use, or the drain in the hydrant may be connected to a storm sewer. For wet ground, where these precautions cannot be carried out, special hydrants are available which permit pumping out after use.[10]

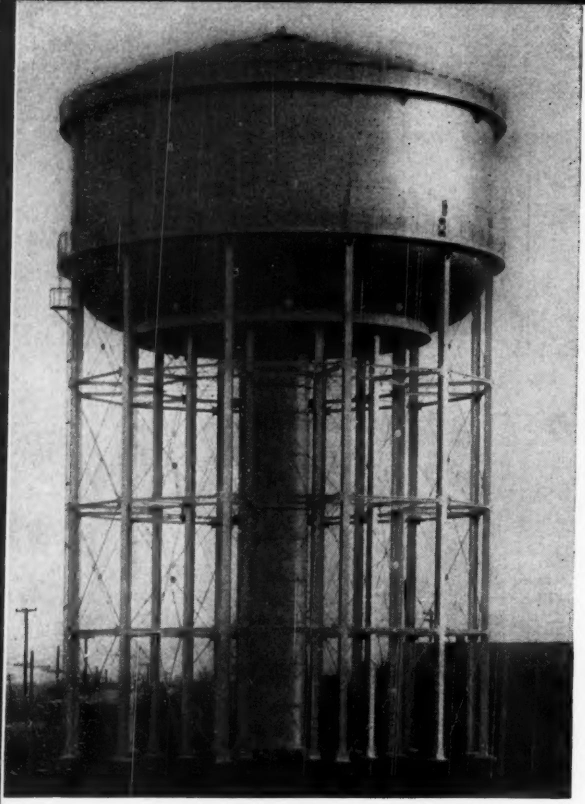
Where the character of the soil is such that frost heaving may occur, sand or gravel should be placed around the hydrant barrel all the way to the ground surface. In filling around the hydrant, the backfill should be tamped in 6-inch layers. Some hydrants have a tapered sleeve so that frost heaving will cause soil to pull away.

After the hydrant is connected and installed, the nozzle caps should be removed, and the hydrant thoroughly flushed; the hydrant is then closed, the nozzle caps replaced, and the valve again opened to determine if all connections are tight. If not, they should be made so. The flushing out procedure is highly important. Many valve seats have been damaged by attempting to close with obstructions under them.

Maintaining Hydrants.—Inspections of hydrants should be made about every six months. With all nozzle caps closed, opening of the valve will show leaks in the stuffing box. Any leaks should be repaired. With the top or bonnet removed, the lubrication should be checked and renewed, if necessary. The bonnet is then replaced, the nozzle caps removed, and the hydrant opened fully. The act of opening and closing lubricates the upper working parts. After closing, the nozzle caps should be

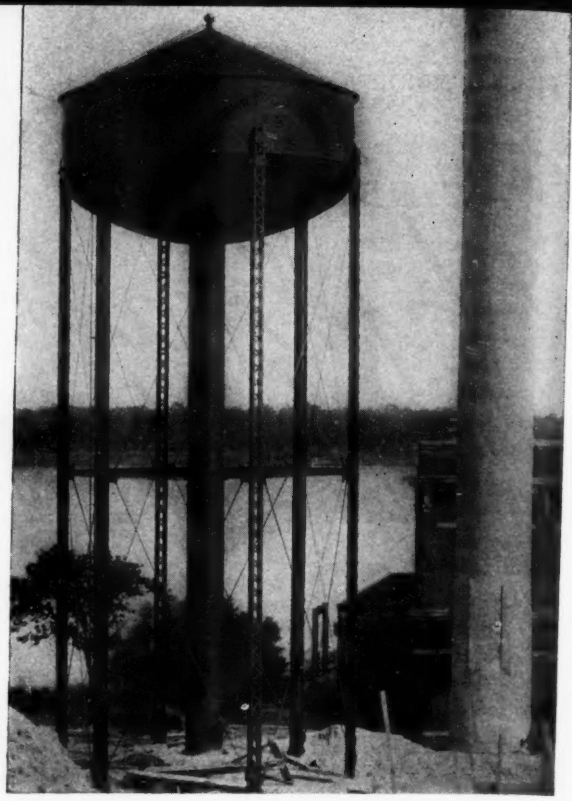


20. How to set a hydrant



21. Two sizes of elevated tanks; one large, one small

Left: Toroidal bottom tank, 1,000,000 gallons capacity. Diameter 71 ft., depth of water 35 ft.



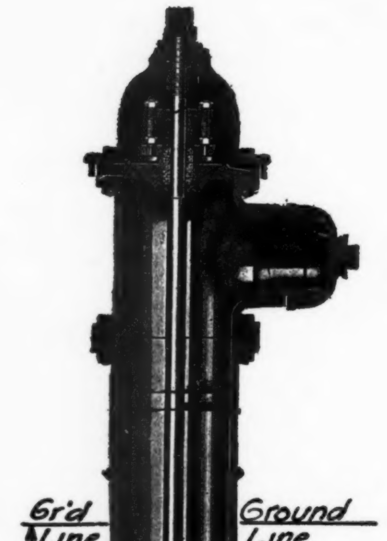
Right: Wash water tank at Dallas, Tex.; 80,000 gal. capacity; diameter 32', depth of water 16' 2". Ellipsoidal bottom

left off long enough to permit the hydrant to drain fully.

If the hydrant does not drain fully, the drain outlets are probably clogged. Most hydrants are so constructed that the pressure of the water can be used to blow out clogged drain holes.

If a valve is located on the connection between the main and the hydrant, this should be closed completely and opened fully. The threads on the nozzle outlets should not be oiled, but may be cleaned with a stiff wire brush. A leaking hydrant should be removed and replaced. The type of hydrant that is made with a replaceable barrel or top section of barrel eliminates most of the work and cost of replacement if the hydrant is broken by a truck or other vehicle hitting it. Such models are made by nearly all hydrant manufacturers.

How to Order Fire Hydrants.—The *size* of a fire hydrant is the diameter of the valve opening at the bottom of the hydrant. The *inlet* size is the size of the pipe to which the hydrant will be connected—usually 6-inch. The size and kind of pipe should be given; also whether the hydrant is to have a bell or a spigot inlet. *Bury* is the distance from the bottom of the trench to the ground surface, and is the same as the trench depth. *Cover* is the distance from the top of the connecting pipe to the ground surface. The size and number of hose connections wanted should be stated; also the threading. Preferably, this should be the Underwriters standards; but if the existing hydrants have a different thread, it is best to send a male coupling from a wornout section of hose. If a pumper connection is desired, give the same data as for the connections. The *operating nut* of National Standard is 5-sided, 1 7/16 inch from point to flat at the top, but other sizes are used. The shape and size of nut should be specified; also the direction of opening—clockwise,



22. WHAT'S WHAT ON A HYDRANT

The notations refer to the text matter herewith and illustrate important points to consider in ordering hydrants.

to the right; or counterclockwise, to the left. Always give the direction to open, and not to close. *Color* desired should be specified exactly.[11]

Winter Care.—After snowstorms, hydrants should be shovelled out promptly, so as to be available for use in case of emergency.

A drain is provided to remove the water from the hydrant barrel after use. In the fall, an inspection of the hydrant should be made to determine if the hydrant is draining, a piece of wood attached to a string can be let down through a hose connection opening to determine if water stands in the barrel. If it does, the drain should be opened.

In exceedingly cold weather, hydrants should be tested to determine if they or the connecting pipes are frozen. If frozen, they must be thawed out. Steam or electric thawing is generally used. Hydrants that experience has shown are likely to freeze may be banked with straw, leaves or manure as a protection.

Fire hydrants do not freeze if empty, and water should not be permitted to stand in them in winter. (When present, it is due to failure to drain after use of the hydrant, or to ground water entering through the drain hole.) If water is found in them, it should be pumped out at once; and if due to ground water, the drain hole should be closed and the hydrant pumped empty after each use; and as soon as practicable the cause be removed by drainage, or the drain hole connected to a storm sewer or other drain. Special pumps for emptying hydrants are obtainable.

Elevated Tanks and Standpipes

Function.—The rate of water consumption varies, while it is desirable to operate pumps at a uniform rate, or to use a main

which while of ample average capacity, may be taxed by hourly or other peak demands. A distributing reservoir permits equalizing the demand and supply. In many cases, especially in sections where there are no hills, elevated tanks or standpipes are the most satisfactory form of distributing reservoir. These are built of steel in a variety of forms, heights and sizes. The elevated tank is usually supported on 4 or more standards; if desired, the entire structure may be housed in a stone, brick or concrete structure.

Advantages.—By permitting pumps to be run uniformly at the rate at which they are most efficient, such an elevated tank may be a decided economy. It also provides a reserve to care for excess demands or for fires. It may improve pressure and service materially in areas where the distribution system alone, at times of heavy water usage, can not furnish enough water. It also provides a reserve for use in case the pumps are shut down temporarily or the supply main fails.

Location.—In general a tank or standpipe should be located near a center of heavy water consumption; preferably so that such center is between the tank and source of supply, so that water can be fed to the area of heavy consumption from both directions in case of fire or other peak demand. High ground is desirable, as it reduces the height to which the tank must be built and reduces the cost; but it is more important to locate the structure near the center of demand.

Capacity. — So many factors operate locally to affect the most desirable capacity that no recommendations can be given here. The relative size of the community, fire protection demands, number and size of supply lines and cost are all factors. The capacity should be at least one-third the average daily consumption; the pressure provided should be 40 or 50 pounds as a minimum (See section on pressures in distribution systems).

Range in Head.—It is important that the range in head between the upper and lower water levels in an elevated tank be reduced usually to 20 or 30 feet. If the range is large and the tank is built with a height to top to give a desirable pressure, the lower portion of the capacity will be delivered at a pressure too low to be serviceable. If the height to bottom is such as to make all of the capacity available, the structure will have an unnecessarily great overall height and all the water must be pumped against an average pressure greater than necessary.

Maintenance.—Rust prevention is one of the most important factors in maintenance. This is accomplished by protecting the metal surface by proper painting. It is best practice not to wait until the surface actually needs protection, as evidenced by the formation of rust, but to clean and paint both inside and out every three to five years as regular routine.

Proper cleaning of the steel surface before painting is most important. All scale and rust must be removed by wire brushing or sand blasting. A coat of paint having an "affinity" for steel should then be applied. If this is properly placed, only one cover or finish coat is necessary. Painting should never be done in wet or freezing weather.

Aluminum paint is used frequently for the outside of the tank; 2 coats are usually required. Inertol "55" black can be used for the inside of tanks and standpipes as it is quick drying and taste-free. Red lead, one or two coats, is frequently used where the water is not corrosive.

All tanks should be equipped with an altitude gauge to indicate the amount of water in it, preferably with remote indication at pumping plant or superintendent's office. If desired, a remote control can be installed that will automatically start or stop pumps, thus maintaining closely any desired level of water in the tank.

Freezing.—Ice is not dangerous if the tank is properly designed for cold weather. Freezing may occur where pipes or water passages are too small or are improperly protected. Good protection is therefore important, and if trouble may occur from freezing of the riser, this may be protected.

In cold sections, an overflow pipe should be provided outside of the tank. During cold weather, circulation in the tank should not be allowed to cease entirely. If the use of water is intermittent or very small, a small waste line should be provided with a valve which may be left partly open

so as to assure some use of the water and movement in the tank.

If the riser freezes, care should be taken in thawing it out. Do not drain the riser and then thaw from the bottom up, in order to take advantage of the weight of the water above. Sooner or later the ice plug will blow out and usually will damage the riser.

Sterilizing Tanks. — Elevated tanks, concrete or steel reservoirs, and other similar structures, should be chlorinated before being placed in service either in the first place or after cleaning or painting. Liquid chlorine may be added to the water as these are being filled; or ½ to 1 pound of bleaching powder, 25% available chlorine, may be used for 1000 gallons of water.

Care of Reservoirs

Cleaning and Algae Control.—On those reservoirs which are accessible to the public, or can be seen from a public highway, every effort should be made to keep the area neat and clean. Grass should be kept mowed, and the growth of weeds prevented, or the weeds kept closely cut. Undesirable brush and small growth should be kept trimmed down. Planting of trees, usually of the pine family, adds a great deal to appearance, makes future maintenance work simpler, and has other advantages.

Growth of algae should be prevented by timely application of copper sulphate, both for appearance and to prevent possible rapid clogging of the filters. Full directions for algae identification and control have been given.[13] If possible, leaves should be kept from the surface; the establishment of pine growths around the reservoir, especially those with branches close to the ground, reduces materially troubles from leaves blowing into the reservoir. Distribution reservoirs should be emptied, cleaned and washed at least once a year. Sediment should be flushed out, the bottom and sides scrubbed and the entire interior washed out.

Fencing.—Distribution reservoirs should be fenced. One important reason is to keep frogs, salamanders, newts and similar nuisances out of the water. For this purpose, the fence for at least 24 inches high should be of ¼-inch mesh, with the bottom fitting close to the walls of the reservoir. In Manchester, N. H., wire fences 8 feet high are used around all reservoirs; these have one-strand of barbed wire on an angle at the top.

Chlorination

Chlorination is the final safeguard of the quality of the water. In many plants it is the only form of treatment. The necessity for its continuous and regular application in sufficient amounts to make the water safe cannot be overemphasized. Chlorine is employed primarily in the form of liquid chlorine; also, in smaller plants, as calcium hypochlorite.

Liquid chlorine is 100% available chlorine. Actually it is a gas, but under pressure it becomes a liquid in which form it is shipped in steel cylinders. The pressure varies with the temperature from 40 to about 150 pounds, being greatest at high temperatures. The cylinders most used in waterworks plants contain 100 or 150 pounds of chlorine, but larger and smaller containers are available.

Liquid chlorine is applied to water by means of a chlorinator which is designed to take the liquid chlorine from the cylinder, measure it, and feed it in predetermined amounts into the water. Application may be in either of two ways, *directly* to the medium being treated, as a gas—or first mixed with water and the resulting *solution* applied. These two methods are known respectively as "direct feed" and "solution feed." The solution feed is preferable for most conditions.

In making application against pressure in pipe lines, various factors enter in fixing the water pressure necessary to operate the injector. A practical minimum ratio is at least 4 to 1, or an increase of 4 pounds in water pressure to the injector for every pound increase in back pressure.

Operation of a Chlorinator. — For proper operation, the chlorinator room should be kept over 50° F. Warm chlorine gas entering a colder chlorinator will condense and may cause clogging, Therefore, the chlorinator should not be on an outside wall, but in a warmer place than the

cylinder or the pipe connecting the cylinder and the chlorinator. A radiator, a small stove, or an electric heater may be used. The chlorinator building should be insulated or well protected. Chlorine cylinders should be kept on scales and the weight read each day as a check against the amount of chlorine used; or in the case of very small plants, the scales should be read every week. The maximum draw-off or discharge from 100 and 150 pound cylinders at 70° F is approximately 35 pounds per 24 hours. Due to the change from a liquid to a gas, an excessive drop in temperature will occur and if more than 35 pounds are used daily, 2 or more cylinders should be attached.

A reserve of chlorine should be kept on hand; also a reserve of duplicate parts including valves, gaskets, etc. The operator should not attempt major repairs. Whenever possible an entire duplicate chlorinator should be kept on hand for possible emergencies. Ask the manufacturer of your chlorinator for full directions for starting and stopping, and for other details regarding it.

Chlorine leaks are dangerous since the gas is irritating to the lungs and causes violent coughing. A concentration of 1 part of chlorine in 100,000 can be noticed; 1 part to 50,000 parts of air causes inconvenience; and 1 part in 1000 of air after 5 minutes exposure produces death. Leaks in valves, connections and other places that may permit chlorine to escape are tested with an open bottle of ammonia. White fumes of ammonium chloride are formed when chlorine combines with ammonia. A gas mask should be kept at hand for use in case of leaks. Chlorine being heavier than air, ventilation at or near the floor level is desirable.

Metal parts on the chlorinator, or other metal surfaces, become corroded when gas is present. To prevent this, these may be painted with a thin coating of vaseline which is sufficient protection.

Dosage of Chlorine. — The dosage of chlorine required for making water safe depends on many factors. Waters that contain iron or manganese may require large amounts. Clear surface water of good quality requires a dosage of 0.2 p.p.m. to 0.5 p.p.m. The chlorine residual test is the essential guide to the amount of chlorine required. Most waters are effectively treated when there is 0.1 p.p.m. to 0.2 p.p.m. of residual chlorine present 10 minutes after the chlorine has been applied[9].

Chlorination With Calcium Hypochlorite.—The HTH, Perchloron or bleaching powder is mixed with water, and settled; the resulting solution containing the chlorine is then fed into the water to be chlorinated. Effective treatment cannot be obtained by feeding the dry bleach. Reliable equipment is available for applying solutions and controlling the amount of chlorine in accordance with the rate of flow of water.

It is easier to fed a weak solution using larger quantities than to apply small amounts of a concentrated solution. Solutions lose strength on prolonged standing (more than about 6 weeks). Solutions should be made up weekly, in which case there is no measurable loss of strength.

Computing Dosages. — To chlorinate 100,000 gallons of water per day, using bleach, with a dosage of 0.4 p.p.m. of chlorine, the required amount of bleach is computed as follows:

100,000 gallons weighs 834,000 pounds or .834 million pounds; chlorine required is .4 x .834 = .33 pounds of chlorine. If the bleach has a strength of 25%, there will be required .33 ÷ .25 = 1.32 pounds of bleach. If a ½% solution is to be used, the 1.32 pounds of bleach will be mixed with 264 pounds or about 32 gallons of water. If HTH or Perchloron are used, and these have 70% available chlorine, the amount needed will be .33 ÷ .70 = .47 pounds or about 7½ ounces.

Ammonia-Chlorine.—When water contains such industrial wastes as phenol compounds, the addition of chlorine causes a disagreeable taste; the same trouble may occur if algae are present in considerable quantity in the water. If ammonia is added to the water a few seconds before the chlorine is added, the reaction between the chlorine and the taste-producing organisms is prevented, and much or all of the taste problem is eliminated. The use of ammonia also permits the use of larger doses of chlorine without causing chlorine tastes. When used solely for the latter purpose, the ammonia may be added after, rather than before the chlorine.

When ammonia and chlorine are used, the two chemicals combine to form chloramines which do not react as quickly with organic matter as does chlorine alone. Consequently, the rate of disinfection is slower, and a longer period of contact is required. Water treated with ammonia and chlorine should not be used, therefore, until about 2 hours after treatment.

An advantage of the use of ammonia with chlorine, is that in small plants, without full-time attendants where the flow or usage of water varies materially from hour to hour, and where the chlorine dosage is not regulated by automatic equipment in accordance with the volume of flow, the heavier dosages during periods of low flow are less likely to cause tastes.

Ammonia is ordinarily furnished in cylinders of the same type as are used for chlorine; and application is by means of equipment practically the same as that used for applying liquid chlorine. Chlorinators cannot be used, however, since different metals are necessary to prevent corrosion. Ammonia is also available as aqua ammonia, in which form it is fed by the same type of proportionally controlled equipment as has already been described under "Chlorination with calcium hypochlorite."

The dosage of ammonia required depends on the characteristics of the water. Ordinarily it is 1/3 to 1/2 of the chlorine dosage although recent experiences indicate that proportional doses up to, possibly 1/10, may be efficient. When using ammonia, a higher chlorine dosage is commonly used—sufficient to maintain a residual of about 0.4 p.p.m.

Testing for Chlorine Residual.—After water has been chlorinated, the presence of residual chlorine can be determined by the orthotolidine or the starch iodide tests. The former enables the operator to determine easily how much chlorine remains in the water and is therefore generally more valuable and is more widely used. These tests have been described fully[9].

Taste and Odor Control

Tastes and odors do not cause disease and usually do not indicate dangerous contamination. But when they render a supply unpalatable, the consumer is likely to turn to other supplies, often less safe, as wells, springs or bottled water. To protect the health of the community by furnishing a safe and a palatable water at all times is the duty of the water official.

Sources of Tastes and Odors.—The most common sources of tastes and odors in water supplies are plant growths of the algae type. Some of these organisms exude oils or other products which impart a disagreeable taste to the water, especially in combination with chlorine. Decaying vegetation, as leaves, grass and moss, is often a contributing cause. These are particularly evident when reservoirs are low, and contain swampy or stagnant areas.

Severe and troublesome taste and odor conditions are often due to industrial wastes from coke plants, chemical plants, canneries, tanneries, oil refineries, and dairies.

The prevention of tastes and odors in the water may be accomplished by preventing the formation or growth of substances that may cause taste as in the case of algae; by preventing the entrance of industrial wastes into the supply; by neutralizing or destroying the taste and odor-producing substances or by removing them. Local conditions will usually determine which of these will be most effective and economical. A full discussion on these factors has been prepared by Sigworth.[13] Activated carbon, aeration, super- and de-chlorination and algae control are used in controlling tastes and odors.

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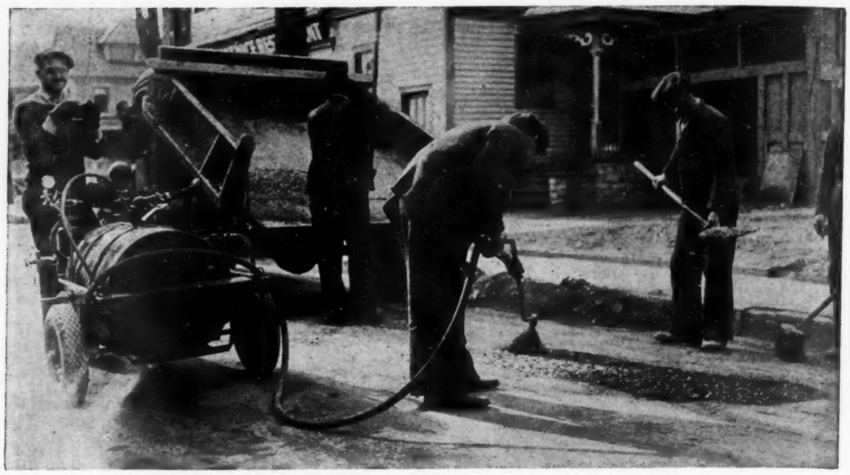
This is the sixth installment of this article. Another will appear in the July issue; and thereafter from time to time. Our particular appreciation for assistance in preparing this section goes to Messrs. Taylor, Martin, Wiggin, Chrystie, Nikirk Milligan, Conzelman, Davis, Richardson and many others.



Perfect contouring of patches, penetrated in place, is possible with one of these "direct from drum" sprayers. (Courtesy Tarrant Mfg. Co.)

How to Maintain Highways and Streets

Maintenance of Macadam Roads

Bituminous macadam roads are quite widely used; waterbound macadam is no longer so generally built (E. L. Gates and many others still build these), but there are considerable mileages still in use, generally protected by a surface treatment or similar bituminous cover. Maintenance procedures are essentially the same, no matter what the type of macadam.

A bituminous macadam road consists of a base course of 6 or 8 inches of broken stone, usually placed in two courses, each of which is rolled. On top of this is a wearing course two or three inches thick. The base courses are not usually penetrated with bituminous material, though an application of bituminous material is sometimes made on top of the base layer in order to obtain a bond with the wearing course. (E. L. Gates always uses a binder.) In other cases, the base course is choked with fine aggregate or dirt to prevent the tar or asphalt from running down into it. (Mr. Gates never uses this construction.)

The aggregate for the wearing course is usually 1 to 2-in. for tar; 1¼ to 2½ inch for asphalt; this is spread to a loose depth of 3 or 4 inches and rolled; bituminous material is then applied by means of a pressure distributor and choke material —½-in. to No. 8 for tar; ¾ to 1¼-inch for asphalt — is spread and the surface rolled. A seal coat is then placed, after a curing period, using a light application of bituminous material and covering with ⅜ inch to No. 8 aggregate.

"Base courses of crushed stone, regardless of finished depth should be built up in layers never exceeding 4" in loose depth: Ofttimes such courses are penetrated with asphalt and are known as a black base. Eight inches of crushed stone, regardless of how well it may be rolled does not give the strength of a tight base filled with some type of small aggregate. Bases filled with bank-run gravel, containing up to 15% of clay or loam, or a limestone dust, usually make the best fillers, except in cases where the ground water must be considered, due to capillary attraction, and then clean coarse sand is used as a filler, and due to lack of capillary attraction, serves as a water break base course for the pavement.

"As to the aggregate for the wearing course, I believe the tendency is towards smaller aggregate, and I would suggest for the penetration course 1¼" to 2" and for the choke material ⅜" to ⅝" stone, which can also be used as stone screenings in blotting a squeegee course, particularly if a non-skid surface is important." (G. R. Christie, Standard Oil Co., N. Y.)

Penetration macadam is built with both hot and cold bituminous products; in the latter case the maximum size of stone is usually about 1½ inch and, since a lighter grade of bituminous material is used, this is usually spread in two applications.

Problems in Maintenance. — Maintenance of surface treated macadam and bituminous macadam surfaces will cover a wide variety of work, principally because these old surfaces form a good foundation for newer surfaces, including lighter surface treatments or mixed-in-place tops. Therefore, maintenance activities may include any or all of the following: Patching, surface and other treatments, crown reduction, widening and skid-proofing.

When macadam surfaces must be broken up to replace defective subgrades or to install culverts or other improvements, removal is accomplished with picks and shovels on small jobs and with rooters or scarifiers on larger jobs. The limits of the area to be removed should be plainly marked and so planned that there is plenty of room to work in, which should be done without destroying an excess of the pavement. The pavement material that can be used over again and should be piled at one side. The edges of the pavement opening should be approximately vertical and care should be taken to see that these are not broken or cracked, nor undermined.

Replacement of such areas should be made with essentially the same material as was used in the original construction, and in the same manner. Backfill material must be allowed to settle or the trench properly compacted, or filled with sand, gravel or lean concrete.

Patching.—In patching macadam pavements, the hole should be well cleaned out, preferably to a rectangular shape, with vertical edges; and the patch material should be of the same type and size of aggregate as in the original surface, so far as possible. In waterbound macadam, patches should be compacted in layers of about the same thickness as the original, and the top, covered with screenings, broomed in and watered, should be the same elevation as the surrounding material.

On bituminous macadam, the hole should be treated in the same way, except that the top three inches should be built up as a penetration surface, that is by penetrating the stone with the same type of bituminous material that was used in the original work. After choking, a seal

coat should then be applied. Thorough compaction is necessary. The finished patch should be the same elevation as the remainder of the surface, or it may be slightly lower, and then built up with a seal coat.

Where a mat that has been placed on a waterbound surface scales or breaks, the area that is damaged should be removed, the old surface cleaned and primed with a penetrating bitumen. A binder should then be applied and covered with an aggregate of the same type as was used in constructing the mat. Tar and asphalt heaters and sprayers are desirable for work of this type.

Paint patches should be applied as already described for sealing raveling areas, filling minor depressions and sealing cracks. (See Public Works for May.)

Preventing and Repairing Surface Failures.—Macadam appears to be sensitive to subgrade moisture and when moisture seeps through the surface, preventive measures should be taken at once. These will be primarily subdrainage. Unless such subdrainage can be effected by boring under the surface and installing perforated pipe, the section of pavement affected should be removed, adequate subgrade drains installed to remove the subsoil water, and the surface replaced. It will usually pay to place a layer of 3 to 6 inches of stone or other porous material, properly compacted, over the excavated area to form a foundation for the new section. E. L. Gates suggests carrying a drain of such coarse material through the shoulder.

Correcting Depressions.—Low spots in the surface of a penetration macadam road can be built up with a penetration patch. This will not involve the removal of any of the pavement, but the patch will have to be feathered out to match the contour of the road. Therefore, fine aggregate must be used at the edges. Any bituminous material suitable for penetration work can generally be used. Too much bituminous material may cause a "fat spot." It is best to build up the area to a level slightly below the level that is desired, and then by means of a seal coat that is dragged, bring up the area to the proper level. A. R. Taylor states that a cold patch material mixed with aggregate is better suited for building up low spots.

Patching vs. Surface Treatment.—If a surface treatment mat on an old macadam is dead or broken, it should be repaired or renewed. In considering which procedure should be adopted, the amount of patching necessary, its cost and the probable length of time before a new treatment will be needed will be the most important factors. Renewing of the surface treatment, that is, placing another coat, is largely machine work, which is ordinarily cheaper than hand work; a new surface treatment will remove many minor irregularities that hand patching will not affect. There can be no fixed rule as to which procedure should be followed. Generally, however, if 10% of the surface area is in need of repairs there should be no question about proceeding with a new treatment, in preference to patching the broken areas.

Correcting Fat Spots.—Fat spots that develop on bituminous macadam preferably should be repaired by burning off the excess bitumen rather than by adding additional aggregate. A small surface heater should be used. This should be kept in place only so long as is necessary to soften the bitumen and permit it to be cut away. The repaired area may then be covered with screenings or sand.

Road Mix Surfaces

The mechanical mixing of bitumen and aggregate while on the roadbed is termed "road-mix" (as contrasted to pre-mixing in plants). Stone is spread on the previously prepared surface of the road; tar, asphalt or emulsion is then applied by means of a bituminous distributor. The stone and bitumen are mixed by means of heavy maintainers, blade graders, harrows, or special spreading and mixing equipment, planed smooth and rolled.

This type of surface is also called retread, oil-mat, turn-over and mulch treatment. These terms (and also road-mix)

The new Huber maintainer unit

should be restricted to surfaces having a thickness of 1 inch or more, requiring *approximately* 80 pounds or more of aggregate and 0.8 gal. of bituminous material per inch of depth.

There are two general types of road-mix surfaces: 1. The coarse or macadam aggregate type, in which the mineral aggregate is all ½ to 1½-inch particles. 2. The dense graded aggregate type in which the largest aggregate particles are 1½-inch, but a considerable percentage of the material passes a 10-mesh sieve. Construction procedure differs for these types, and different bituminous products must be used in their construction.

An advantage of this type of surface is that it can be constructed with the equipment that is, or should be, available in every township, county, village, city or state highway department, and that is needful also for proper maintenance, and for doing the many construction, repair and placement jobs normally necessary for properly conserving the highway investment.

The Macadam Aggregate Type.—The essentials of construction for this type of surface are, first, a well drained and firm base; second, application of a bituminous priming coat; third, a layer of coarse aggregate; preferably ½ to 1½-inch size; fourth, application of bituminous binder and mixing of the aggregate and the bituminous binder; fifth, rolling; sixth, application of a seal coat.

In this type of surface, interlocking of the aggregate and the reinforcement of the bituminous binder provides strength and stability. Thorough rolling is necessary. A bituminous material of relatively high vicosity should be used.

While the character of the materials that are at hand is important, this type may be chosen for resurfacing any well-bonded road having a surface that shows little or no movement under traffic, as macadam, compacted gravel, stabilized, sand-clay, or shale; also for resurfacing old bituminous, brick, block or similar pavements.

Dense Graded Aggregate Road Mix.—Gravel or crusher run stone is the usual aggregate for this type of surface. All particles should preferably pass a 1-inch or 1¼-inch screen, 50% to 70% pass a ¼-inch screen, 35 to 60% pass a 10-mesh sieve and 5% to 14% a 200-mesh. The strength of the surfacing depends on proper filling of the voids. Therefore for the material passing the 10-mesh sieve, field moisture equivalent should not exceed 20% and lineal shrinkage 3% to 5%; a swell test may sometimes be desirable to determine the fitness for use of the aggregate.

Aggregate may be entirely new, that is, brought in; be obtained by scarifying the existing road; or come from both sources. Loosened material should be harrowed and pulverized so that no lumps of old aggregate exist. New aggregate, if used, should be thoroughly mixed with the old by disk and tooth harrows and blading; it should be obtained in two sizes—one above ¼-inch and one below ¼-inch.

When there is considerable 200-mesh material present, simple laboratory tests are desirable to determine the amount of bitumen required.

Surface Maintenance.—Road-mix surfaces should be watched carefully during the first winter for indications of raveling and potholing. In the coarse macadam aggregate type of surface, potholing and raveling are the principal source of surface repairs. These failures may be caused by the use, in construction, of an insufficient amount of binder, or by the lack of a seal coat, which may permit water to pass through the surface and soften the subgrade.

It is necessary to ascertain the cause of failure so that the work of repair may also prevent future failures and reduce necessary maintenance. Where an inadequate base or poor drainage appears to be the cause for failure, the proper correction should be made.

It is generally better to use pre-mixed material for patching and repairing small holes; and on larger areas to use a mixture similar to that employed in the original surface. When the lack of a seal coat appears to be the cause for needed repairs, a light surface treatment with fine aggregate cover will provide the necessary water-proofing. A thin seal coat mixture layer is a more permanent remedy (JHC).

Raveling on a surface of this type will usually require the application of a seal coat or surface treatment if the area affected is considerable. If it is small, the raveled material may be removed and repair effected by patching.

The graded aggregate type of road mix

may also ravel and develop potholes. Potholes should be repaired as described previously under this heading. Raveling, in this type of construction, may be caused also by a deficiency in the amount of bituminous binder used. The method of repair may differ as compared to that used in the macadam aggregate type. The surface may be scarified, a small additional amount of binder applied with a bituminous distributor, the aggregate mixed thoroughly, spread over the road, shaped and compacted. Many of these surfaces can be more economically maintained by applying a tack coat to the old surface and blading on 20 to 40 pounds per yd. of seal coat mix. (J. H. Conzelman)

Surfaces of the graded aggregate type may shove under traffic. This may be due to (1) an excess of bituminous material used in the origiual construction (2) too much moisture present in the bituminous-aggregate mixture at the time of construction (3) sealing liquefier in the road through improper curing.

In the first case, the surface is scarified and the trouble caused by a surplus of bituminous material is corrected by adding aggregate in order to obtain a properly proportioned mixture. The determination of the required additional aggregate will usually be a laboratory job, though good results will sometimes be obtained by experimenting on a small scale at first, and when a satisfactory mixture has been obtained, going ahead with the whole job.

When excess moisture in the mixture (or too much liquefier) is the cause of raveling, the surface is scarified, and the material allowed to dry out thoroughly. If necessary, drying can be hastened by blading the mix back and forth. When the proper moisture content has been reached, the mix is spread over the road surface, reshaped and recompacted. In general, a moisture content in the mixture at the time of placing of more than 1½% may cause after trouble.

Shoulder Maintenance.—Edge construction is often or usually imperfect on road-mix surfaces and, under traffic, edges may tend to break down. This is best prevented by building the shoulders up flush with the edges of the pavement and maintaining them in such condition that they will give support to traffic loads that come on or near the edges. In soils that drain poorly, the shoulders may be maintained with a little more slope than normal in order to carry off surface water quickly and reduce absorption. The use of stabilized or treated shoulders may be desirable.

High shoulders that prevent water from draining off the surface or traffic ruts at the edge of the pavement are likely to contribute to edge failures.

Maintenance of Hot-Mix Surfaces

The material in this section refers particularly to the so-called bituminous concrete, but also to sheet asphalt, asphaltic limestone, and to the variations of these types. In bituminous concrete mixtures, the aggregate consists of a proportioned mixture of material from dust to 1-inch or 1¼-inch material, to which is added 5% to 8% of bituminous material. The mixing of the aggregate is accomplished in mixing plants especially designed for heating, proportioning and mixing the materials. These are usually located at a central point, as at a railroad siding, and the hot mix is hauled to the job. Under suitable conditions, using a softer bitumen and higher temperatures, hauls up to 20 miles may be made. Also, portable plants, designed for quick knockdown, moving and assembling, are available.

The hot mix is spread on the prepared road surface, shaped and rolled. While hand methods of placing can be used, spreading and finishing equipment is available which produces a smoother and better finished surface.

If hot-mixes have been well designed, properly mixed and well placed on a properly prepared base, the maintenance work required on them should be relatively small. A firm base and good drainage are essentials.

The conditions that may require maintenance include the presence of potholes, cracks, raveling, the formation of waves or corrugations and surface irregularities.

Crack Repair.—Cracks in hot mix surfaces may be caused by contraction or other movement of the base or by the drying out of the surface. Cracks due to the former usually run crosswise of the pavement; the

latter may run in any direction, irregularly. Generally repair or filling should take place in the spring or fall when the cracks are open. The Asphalt Institute recommends that cracks less than 1/8 inch wide be left untreated, rather than to pour them with a crack filler, especially a heavy type of filler, since under these conditions the crack will not be properly filled, the appearance of the pavement will be unsightly, and with cold weather the cracks will reappear.

With cracks more than 1/8 inch wide, the Asphalt Institute recommends the following method of repair: Clean the crack thoroughly, preferably with a jet of compressed air; then fill it with a lean sand-asphalt mixture, brushing this in carefully until the crack is filled. The proportion of asphalt to sand should be small—not over 2% to 4% by weight. Cutback asphalt is recommended. After filling with the asphalt-sand mix, which has the consistency of moist sand, the surface of the crack should be poured with enough cutback asphalt to seal the top. If cracking is extensive, a light surface treatment should be given to the entire pavement.

Where cracks are poured, running a hot smoothing iron over them after pouring may soften the material sufficiently to better fill the crack, and also helps to make a seal with the old surface.

Ohio (Perry) recommends that crack sealing be done in the fall, preferably in late October, at which time the surface is usually dry and the cracks are well-opened. Wide cracks should be filled by applying bituminous filler and brooming grit into them; narrow cracks should be poured, according to Perry; if a heavy bituminous material is used, it should be heated and used sparingly, and after pouring the crack should be covered very lightly and uniformly with fine sand.

Where traffic is considerable, it may pay to work on half the road at a time; and try to concentrate traffic on the other half. This tends to safeguard the workmen, and may also make more work possible because less time is lost due to traffic interruptions.

Surface Repairs.—Repairs required by the existence of potholes should be made with suitable materials. Pre-mixed materials are widely used, but the Asphalt Institute recommends using the same material as was used in the original construction. In general, maintenance should be so planned and organized that large potholes will be prevented from forming; on small holes, the use of pre-mixed material is suitable. Methods of preparing the hole for patching were described fully in a preceding issue. Careful cleaning of the hole and painting of the edges with bituminous material prior to placing the patch material are essential.

Surface raveling in its early stages, can be treated with the paint patch method already described, but with hot-mix surfaces only a small amount of bituminous material will be needed. Asphaltic limestones and other fine rock asphalts give good results. Careful leveling and smoothing is necessary.

Correcting Surface Irregularities.—In general, the methods already described under this head for macadam surfaces are suitable for hot-mix surfaces. A quick-drying bituminous material is better for a primer, and the aggregate should be of fine material. Where a depression is more than 2 inches deep, it should be filled by building up two or more laminations or layers of repair material. The edges must be feathered out and the patch, as a whole, finished to the proper cross-section by the use of straight-edges, if necessary. The thin edges should be protected with a paint coat or a seal coat.

Waving or shoving of the surface usually requires, for proper repair, that the old affected surface be cut out. If the area to be repaired is extensive, a hot-mix repair is best; on a small area, pre-mixed material is suitable. Before placing either of these, the cause of trouble should be ascertained. It may be due to poor adhesion with the base, in which case the base should be cleaned and properly primed. It may be due to the presence of moisture under the mat, in which case the proper corrective measures must be determined and applied.

Maintaining Soil Cement Roads

The Portland Cement Association recommends the following procedures for maintaining soil cement roads:

Initial Bituminous Surfacing.—After construction, the completed soil-cement roadway should be left open to traffic and

to the elements until it has developed sufficient surface roughness to warrant a thin bituminous surface as a leveling course. The period required will depend largely upon the efficiency attained in knitting down the final surface mulch to the required crown and grade. Should compaction planes be left near the surface, it is probable the overlying soil-cement will become loose.

When the riding qualities of the soil-cement road warrants improvement by the use of a bituminous cover, it should be carefully swept and all dust and loose particles removed with a blower. A bituminous prime of light grade material may then be applied at the rate of about .2 gallon per square yard. This is followed by a tack coat of somewhat heavier material of about the same quantity and this, in turn, followed with about .4 gallon of bituminous material and 25 pounds of chips. The use of prime and tack is optional but it is advisable to use some form of tack coat. (The detail methods of applying this surface should conform to usual practice in the state.)

Heavy duty motor graders oil mixing on county roads

Repair of Failed Areas.—In those areas where the soil-cement roadway fails, due to poor subgrades or to excessive local loadings, the broken material should be removed from the roadway. The space thus made available should be cleaned out to a depth of six to eight inches and filled with a soil-cement mixture of the same cement content, moisture content and density, as originally used on the roadway. In many cases it will be practical to use a small concrete mixer and mix soil from the shoulder, with appropriate quantities of cement. This material can be compacted from the bottom up to the required density with a roller or rammer.

Maintenance of Bituminous Carpet.—When a bituminous carpet wears down to the soil-cement under normal usage, it should be replaced with a seal coat of comparable weight. In case the seal coat shoves and ruts and peels loose from the soil-cement, due to no fault of the grade or quantity of bituminous material used, it should be removed from the soil-cement, the soil-cement carefully cleaned down to hardened material, and the seal replaced in the usual manner.

In case the bituminous carpet shoves or ruts, due to improper quantity of bituminous material, it will be repaired in the same manner as such defects are required on bituminous roads.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Activated Sludge Removal of B.O.D.

The rate of removal of the L value (total carbonaceous B.O.D.) of the substrate is very high for the first half hour, and this high rate may continue for 1½ or even 3 hrs. From 80 to 90% of the L value of a sewage substrate can be removed in five hours aeration with such sludges. The quantity and quality of the sludge influences the rate and extent of total purification accomplished in a given time.

The proportion of the L value reduction of the substrate that is actually oxidized varies from 2.5 to 30% in 30 minutes, and these values are increased to 30 to 60% after 5 hrs. aeration. The proportion of the reduction due to the net adsorption and synthesis (all mechanisms other than oxidation) increases rapidly from the start for from 0.5 to 3.0 hrs., reaching a maximum of 50 to 70% during this period, and then decreasing at a rate which varies considerably in different systems and apparently depends greatly upon the oxidation mechanism. It is apparent, therefore, that biochemical oxidation is a factor of major importance to the success of the purification phenomenon.

The experiments suggest that sludge reaeration as an activated sludge corrective measure is not always the proper procedure; it may be harmful because the bacteria are not maintained in a state of activity for lack of food and the equilibrium between oxidation and adsorption is upset. In general, long aeration of weak sewage is undesirable. From the economic standpoint, the amount of air used should be the minimum sufficient to keep all the sludge suspended and dispersed throughout the liquor and satisfy the oxygen requirements of the aeration mixture.[C34]

Cloths for Vacuum Filters

Several types of cloths are available for use on vacuum filters, choice depending largely on type of sludge: Thin cotton cloth without nap for sedimentation sludge; heavier cotton without nap for raw or chemically precipitated sludge; cotton cloth with nap for well-digested sludge conditioned with ferric chloride and lime; the same with finer texture for sludge containing fine clay; heavy wool cloth for activated or elutriated digested sludge conditioned with ferric chloride only; heavy specially treated cloth without nap for alkaline sludge conditioned with an excess of lime; all-glass cloth for strong acid conditioning; monel metal cloth for highly alkaline sludge. Life of cloth depends on correct adjustment of scraper, optimum amount of conditioning chemicals, washing with weak acid when lime is used, washing off grease with soap solution, wash thoroughly after each filter run, protect from hot summer sun, do not stretch cloth excessively when placing, keep wet to prevent mildew, patch any holes that may occur.[G10]

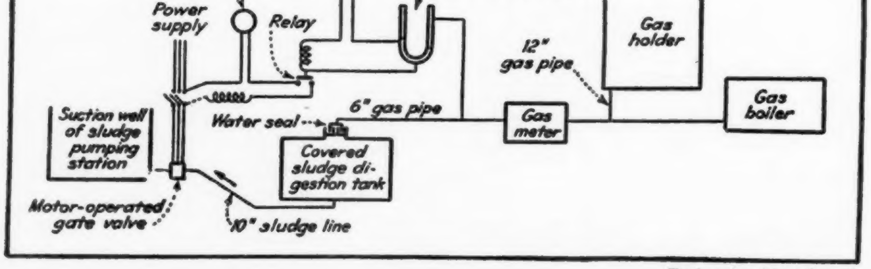
Aeration in Activated Sludge Treatment

If the primary process in an activated sludge tank is a purely physical adsorption which is followed by a slow biological oxidation, then a vigorous aeration immediately after mixing is unnecessary, and the leisurely mixing provided by the Haworth paddles should be sufficient. On the other hand, if the rapid initial purification is not purely physical but involves biological action as well, then the more vigorous the aeration the better the results; the less vigorous types of aeration can then follow to allow the slower biochemical reactions to proceed to completion. Sludge reactivation should again be vigorous in order to remove the last traces of unoxidised matter from the sludge and allow nitrification to commence.

Regarding the influence of *p*H, it will be seen that at a *p*H of 7 the substances adsorbed may be quite different from those adsorbed at *p*H 8; hence a sudden change to *p*H may administer a severe shock to activated sludge. Lumb has found that the activated sludge process is most efficient between *p*H 6-3 and 6-9. Unless acid is added it is not practicable to work between these limits, and where lime is added it is impossible. However, the author believes that, provided the *p*H can be kept fairly constant, consistently good results can be obtained with tank effluents up to *p*H 8.[D29]

Preventing Explosion of Digestion Tank Gas

At the Baltimore Back River disposal works are two 200,600-cu.ft. digestion tanks with fixed covers, the gas generated flowing through a 6" pipe to rotary gas meters and thence to a 200,000 cu. ft. gas holder. To prevent drawing air into a tank through the gas seal when sludge is withdrawn, provision is made to draw gas back from the gas holder. If for some reason this should not operate, an automatic control consisting of a mercury pressure gauge with electric contacts is installed in the gas discharge pipe. If the pressure in this pipe should drop to slightly above atmospheric pressure, a bell would ring and a valve on the sludge draw-off pipe would be closed automatically.[E14]



Engineering News-Record

Automatic control arrangement developed at Baltimore for preventing discharge of sludge from digestion tanks when gas pressure is low

Air Lift Sludge Pumping

Chicago's Southwest treatment works, the largest activated sludge plant in the world, consists of a combined pumping station and blower house, preliminary settling tanks, aeration and final settling tanks, sludge concentration tanks and a sludge disposal building. Steam turbines are used for the main pumping plant instead of motors, partly because most of the elements of a steam plant are required for the sludge disposal method adopted, partly because the plant effluent can be used for

condenser cooling water without further pumping.

But for pumping returned sludge, amounting to 20% of the sewage flow, air lifts are used; this being the only large-scale works in existence where this is practiced. There were three reasons for this: (1) The difficulty of conducting into and out of a common pumping station the very large conduits that would otherwise be required. (2) The difficulty of securing efficient pumps of proper characteristics. (3) The lower cost of the air-lift installation. Two lifts, each 16 in. in diameter, were provided for each settling tank, one for ordinary flows, the other for peak loads. Experience at the North Side works indicates that peak loads of solids 3 to 4 times the average may occur. To provide sludge-handling equipment for such large overloads appeared prohibitive, but by building up storage of these excess solids in the aeration system to the extent of about 1,000 ppm, and later drawing down the stored solids when conditions return to normal, sludge-handling equipment only one-third greater than required for average conditions should suffice. The sludge disposal equipment was designed on this basis, with three units for ordinary service and a fourth for peak load conditions. The large pumping capacity for sludge return is needed to circulate the excess solids during storage periods.[L4]

Ventilating a Los Angeles Sewer

The lower 6 miles of the 10'6" x 12'3" North Outfall sewer of Los Angeles, between a siphon and the outlet, had practically no ventilation and the air in it was found to have as little as 11.7% oxygen; resulting in decomposition of the concrete and liner block joints. To prevent collection of sulphuric acid on the sewer arch, chemical control of the flow of 200 cfs would be too expensive, and removal of the gas by ventilation was tried, evacuating the air at a point 2,000 ft. below the siphon and 31,000 ft. above the outlet, and admitting it at intervals below that. An evacuating fan with a rated capacity of 15,000 cfm was connected to the top of the sewer by a 36" pipe, and has removed continuously 24 hrs. a day about 22,000 cf with a suction of 1.7" of water, using 55hp. Within two months the sewer arch had dried noticeably for a mile from the fan, and was covered with a grayish or yellowish powder, and in a year the whole sewer was dried out. At first the sides had been covered with a wet stringy deposit containing 7% CaO, 4% SO_3 and 12% metal trioxides. The exhaust gas had at all times 100% humidity and contained an average of 16% H_2S. The cross-sectional air space in the sewer varied from 41 to 76 sq. ft., and velocity of the sewage 300 ft. per minute. The evacuated air is discharged into the atmosphere at 150 feet per second; no odors have been noticed in its vicinity.[C37]

Filtering Brewery Wastes

Tests plants for treating wastes of the Gulf Brewing Co. of Houston, Tex. indicated that chemical treatment with lime and ferric salts would reduce the B.O.D. only 55 to 75%, the results were erratic, a large volume of sludge was produced which dewatered very slowly on a vacuum filter. Two trickling filters 6 ft. deep were tried in series and parallel. In parallel at 6 mgad there was practically no reduction in B.O.D. At 2 mgad there was a reduction of 71% and 80% respectively. When operated in series with settling between the two stages, B.O.D. reduction at practically the same rate (double the rate for each filter) reached 94.9%. The reasons suggested were: Better aeration at higher rates of dosing; probably longer total period of contact; greater uniformity of quality of waste in the second filter;

removal of solids by first stage made second stage more effective. The plant built consists of primary and secondary settling tanks; two trickling filters 100 ft. diameter by 6.5 ft. deep, giving maximum loading of 12.8 lb. of B.O.D. per 1000 cu. ft. of filter stone per 24 hrs.; final settling tank; sludge digestion tank designed for 30 days detention; and sludge drying beds. The filters can be operated in parallel or in series with either as the primary.[C41]

Sewer Rentals or Service Charges

There are now more than 600 municipalities in 35 states that finance their treatment plants by so-called "sewer rentals"—a designation objected to by some as misleading, sewerage service charge being preferred. In preparing rates, allow for metered water that will be exempt from them—probably about 25%. Basing rate partly on strength of sewage delivered is correct theoretically, but the difficulty of obtaining representative samples and enormous amount of analytical work involved makes it impracticable; industries producing abnormal sewage can be made the subject of special agreements.[C38]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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March

34. *t*. Total Purification, Oxidation, Adsorption and Synthesis of Nutrient Substrates by Activated Sludge. By C. C. Ruchhoft, C. T. Butterfield, P. D. McNamee and Elsie Wattie. Pp. 195-225.
35. *t*. Carbon and Nitrogen Transformations in Purification of Sewage by the Activated Sludge Process. By H. Heukelekian and M. L. Littman. Pp. 226-250.
36. Tallmans Island Sewage Treatment Works. By H. Liebman and E. J. Fort. Pp. 251-263.
37. Experimental Ventilation of the North Outfall Sewer of the City of Los Angeles. By E. G. Studley. Pp. 264-270.
38. Sewer Rentals. By R. C. Sweeney, R. A. Allton and W. F. Tempest. Pp. 271-283.
39. Financing Sewage Treatment by Sewer Rentals. By M. W. Tatlock. Pp. 283-289.
40. Legal Aspects of Stream Pollution. By J. A. Tobey. Pp. 290-294.
41. Treatment of Brewery Wastes. By R. J. Bushee. Pp. 295-307.
42. Laboratory Stirrers. By W. D. Hatfield. Pp. 308-314.

D *The Surveyor*

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27. *p*. Sludge Digestion. By H. W. Taylor. Pp. 545-546.

April 28

28. *t*. Conditions of Surcharge in Sewerage Systems. By L. B. Escritt. Pp. 563-564.
29. *p*. Determination of the Performance of the Kessener Units at Stockport Sewage Works. By D. Dickinson. Pp. 565-567.

May 12

30. *p*. Sewage Disposal System of Cairo. By C. Hammerton. Pp. 619-620.

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32. *p*. The Biology of Sewage Purification. By T. G. Tomlinson. Pp. 655-658.

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14. Preventing Gas Explosions in Sludge Digestion Tanks. By C. E. Keefer. P. 66.

H *Municipal Sanitation*

May

27. The Whole Truth About Hog Feeding. By W. H. Wright. Pp. 268-270.
28. Activated Sludge Plant for Birmingham, Mich. By W. R. Drury. Pp. 271-272.
29. Cedar Rapids Trickling Filters Show High B.O.D. Removal. By J. C. McIntyre. Pp. 273-275.
30. A Fully Mechanized Plant for 3800 People. By P. Mitchell. P. 276.
31. Commuter Community Served by Separate Digestion Plant. By H. O. Johnson. Pp. 277-278.
32. Electrical Equipment Maintenance. By L. M. Johnson. Pp. 282-284.

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8. *p*. Sewage Sludge and Screenings Disposal by Incineration. By C. A. Emerson. Pp. 50-51.
9. *p*. Using By-product Power at Sewage Treatment Plants. By E. D. West. Pp. 59-60.

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4. The Southwest Sewage Treatment Works. By W. H. Trinkaus. Pp. 285-288.

P *Public Works*

May

23. WPA Makes and Lays Five Miles of Concrete Sewer at Spokane. P. 13.
24. Three Years' Results in B.O.D. Reduction with Chemical Coagulation. P. 16.
25. *p*. Kessener Brush Aeration at Stockport, England. P. 20.
26. Designing Automatic Sewage Pumping Stations. Pp. 21-22.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Recovering Lime from Softening Sludge

Sludge from the lime process of water softening is often difficult and expensive to dispose of. It contains more lime than was added in the treatment, which could be recovered by calcination, presumably at less cost than fresh lime, thus giving a double saving; in addition to which, CO_2 gas for recarbonation would be produced by the kiln. Deterrents have been the presence in the sludge of matters other than lime, chiefly mud (in the case of river water) and magnesium. The former can be removed by pre-sedimentation; but the latter is precipitated with the lime, and as the lime is recovered and used over and over, the magnesium accumulates.

Two methods of solving the magnesium problem are proposed; the Lykken-Estabrook (handled by the Dorr Co.) and the Hoover (Nichols Engineering and Research Corp.) In the former, recovered sludge containing the Mg is mixed with enough water (10% to 20% of the amount to be softened) to dissolve all the lime, enough recovered lime being used to soften all the water being treated. The sludge from this 10% to 20%, containing all the Mg that was in the recovered sludge, is wasted; the clear lime water is used for softening the rest of the water under treatment. In the Hoover process, just sufficient lime is added to precipitate the CaO and not the Mg., and the sludge from this is that recovered. Then additional lime is added to precipitate the Mg and the resulting sludge is wasted.

Colorado river water, to be used by the Southern California Water District, has about 350 ppm total hardness and 25 ppm of Mg. and is to be softened. Sludge recovery was investigated at the Boulder City, Nevada, 2 mgd softening plant, using the Estabrook process. The sludge was dewatered on an Oliver vacuum filter, discharged onto the top hearth of a 6-hearth Nichols Herreshoff furnace, burned, cooled and fed directly back into the softening plant. Tests continued for more than three months "show conclusively that it is feasible, both from a chemical and an eonomic basis, to reclaim lime from the sludge produced during the water softening process and to re-use this lime continuously as the softening agent." Two difficulties presented themselves to be solved: 1) The sludge produced was not readily filterable without using some coagulant. (The Dorr Co. found that heating the sludge to 60° C offered a solution, with thickening and carbonation as additional aids). 2) A considerable amount of lime failed to dissolve in the 10% to 15% of water theoretically necessary, and was lost in the wasted sludge.

Estimated cost of a 100 mgd lime reclamation plant was $600,000; cost per ton of lime produced, including 4% interest and 40-yr. amortization, $4.29, with fuel oil at $1.10 a bbl., power at 1 ct. per kwh, and labor at $6 a day.[A68]

Simplified Bacteriological Examination of Water

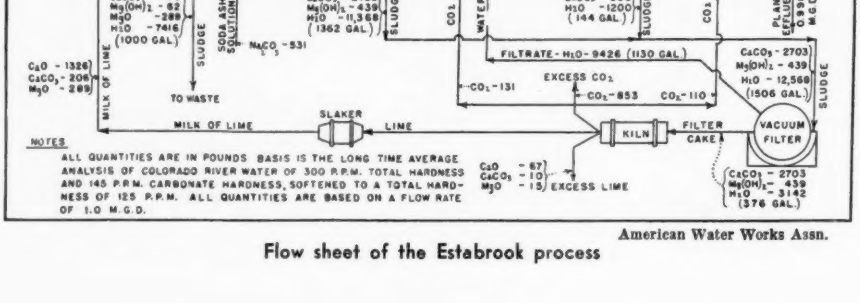
The method described detected coliform organisms in waters passed as safe by the standard lactose broth method, and in 24 to 48 hrs. as against several days by the standard, and with much less of the operator's time required. It does not give quantitative information but the presence of any coliform organisms should condemn a water. It consists of adding concentrated broth to a bottle of the water, incubating for 15 to 18 hrs. and streaking on eosin methylene blue agar, confirming in the usual manner.[A70]

Soil Travel of Sewage Organisms

In determining principles for designing sewage disposal at mountain camps, the Division of Mountain Sanitation of the Los Angeles County Health Dept., investigating the soil with augers and driving rods, and ground-water flow by salt and electric recording equipment, has tentatively concluded that sewage organisms discharged with water into the ground percolate straight down until they reach the water table or an impervious surface, causing a growth of gelatinous coating on the soil grains which removes such organisms and solids; and, on reaching the water table, travel freely with the water, remaining largely at its surface, and there live out their life period but do not multiply. They therefore consider reasonable safety is obtained if the sewage from a leaching trench or cesspool percolates downward through at least 10 ft. of fine unsaturated soil above the water table, and travels in the ground water at least 30 days before reaching any source of water supply. The ground water is found to flow 5 to 50 ft. a day—not over 10 ft. in reasonably fine sand or soil. Water taken from a point 15 to 20 ft. below the surface of the water table is considered reasonably safe.[A72]

Flash-Boards for Dam Spillways

Flash-boards supported by standard steel pipe of ¾″ to 3″ diameter set vertically in the crest of a dam can be designed to fall consistently within narrow limits, thus preventing the head of flood water above the crest from exceeding any desired maximum, but passing ordinary floods without permanent bending of the pipe. The use of pipe seems to be more dependable than of solid steel or iron pins. Formulas for calculating size and spacing of pipe supports are given, and have given results within 5% of the head that had been calculated.[K5]



American Water Works Assn.

Flow sheet of the Estabrook process

Exploratory Holes in Dam Foundation

The rock under the Chickamauga dam (Tennessee Valley Authority) contained many cavities and extensive grouting was necessary. Along the center lines of one cut-off trench exploratory holes were drilled at 100 ft. intervals, but although only one indicated a cavity, excavation revealed two groups of deep, partly-open cavities and an area of large boulders and gravel. Holes had been drilled 100 ft. apart along another trench, but after this experience others were drilled at 25 ft. intervals and revealed many bad areas that the original holes had missed entirely.[E17]

Softening Colorado River Water

Colorado river water supplied by the Metropolitan Water District of Southern California will be softened by the lime zeolite process, a plant of 100 mgd being planned with provision for expansion to 400 mgd. Hardness will be reduced from 300 to 125 ppm. The river water contains calcium bicarbonate and sulphates of calcium and magnesium. Due to the high sulphate hardness, the lime-zeolite process was found to be more economical than the excess lime-soda ash process. Lime can be obtained by reburning the sludge. Both soda ash and salt are available locally but salt especially so.[E18]

Grouting Rock for Dam Foundations

Only one material—cement—is satisfactory for masonry dam foundations; but admixtures such as hydraulic lime can be used to improve the workability; others, such as calcium chloride or lumnite cement, to speed or retard setting; china clay to increase resistance of grout to erosion while setting. Ordinarily, sand should not be used with the cement; it prevents penetration of fine cracks and settles to the bottom of the grout; but fine sand may be permissible, bentonite being added to hold it in suspension, also to lubricate the mix. Instead of sand, rock flour finer than 100-mesh may be used if it does not segregate from the grout when this is poured into a bucket of water. Mixtures vary from 5 parts water to 1 cement, to 0.6 part water to 1 cement, depending on the openness of the seams. Pressures range from 25 lb. for thin horizontal strata to 1000 lb. at depths below 100 ft. in sound rock.

The most satisfactory equipment is a double-acting duplex reciprocating pump, (air injection has several disadvantages), with renewable liners in the cylinders and rubber piston and valve facings.

For other than masonry dams, clay grouts, asphalt and pitch have been used. For solidifying sand and gravel the most common method is to pump in a sodium silicate solution, followed by one of calcium chloride. Others use sodium silicate and aluminum sulfate; silicic acid and a gas that causes it to gel; sodium silicate, calcium chloride and carbon dioxide.[L8]

Vacuum Priming of Pumps at Lewiston, Me.

For pumping its supply from Lake Auburn (90 ft. above the pumping station and 3 miles distant), Lewiston recently installed three 3 mgd pumps and one 6 mgd; to provide for a future average consumption of 6 mgd and maximum of 9 mgd. The pumps are connected directly to the pipe line from the lake and when pumping at 9 mgd would be operating with a vacuum on the suction. A vacuum priming system was installed consisting of 2 horizontal steel tanks mounted higher than the pumps, and an automatic electric motor-driven Nash vacuum pump, with a similar stand-by pump driven by a small gasoline engine, which maintain a vacuum in the tanks. To prevent surges in the line from the lake when

the pumps stop, slow-closing, electric motor-operated valves were placed on the pump discharge lines so that, after the main switch of a pump is thrown, the pump will not stop until this valve has closed. Also, to provide against sudden power failure, two 6" spring-mounted relief valves are placed on the suction pipe, discharging into the river nearby.[VI]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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68. Reclamation and Re-use of Lime in Water Softening. By W. W. Aultman. Pp. 640-679.
69. Short Schools and Operator Qualifications. By C. R. Cox. Pp. 680-688.
70. *t*. Studies on Media for Coliform Organisms. By C. W. Darby and W. L. Mallmann. Pp. 689-706.
71. *t*. Simplified Bacteriological Examination of Water. By J. E. Weiss and C. A. Hunter. Pp. 707-713.
72. Sanitation of Recreational Areas. By F. M. Stead. Pp. 714-723.
73. Recreational Use of Reservoirs. By E. Devendorf. Pp. 724-726.
74. Sanitation Design for Trailer Camps. By E. M. Howell. Pp. 727-729.

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9. Public Surface Water Supplies in Massachusetts. By F. H. Kingsbury. Pp. 1-102.
10. Alignment Charts for the Design of Pipe Lines. By W. F. Covil. Pp. 103-115.

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17. *p*. Reconditioning Steel Pipe Lines in New Zealand. By B. L. Hamilton. Pp. 541-542.

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17. Corewall Grouting at Chickamauga Dam. Pp. 59-60.
18. Soft Water for Southern California. Pp. 64-65.

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19. Raising O'Shaughnessy Dam. Pp. 57-59.
20. Soft Water Will Pay in St. Paul. By R. A. Thuma. Pp. 69-71.

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35. Studies of Water Use and Rates. By R. E. Elgen. Pp. 474-476.
36. A Water Tank Made Beautiful. By H. B. Nurse. Pp. 477-479.

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37. Consumer Records at Louisville, Ky. By N. N. Wolpert. Pp. 532-535.
38. Studies of Water Use and Rates. By R. E. Elgen. Pp. 536-539.

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39. New Pumping Plant Saves More Than Net Cost. By A. T. Cook. Pp. 586-588.
40. *p*. How to Not Soften Water. By O. Rice. Pp. 590-593.

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10. Model of Filtration Plant Helps Educate Public. Pp. 45-46.
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5. Flash-Board Pins. By C. A. Wright and C. A. Betts. Pp. 771-803.

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9. *t*. A New Method of Presenting Data on Fluid Flow in Pipes. By A. A. Kalinske. Pp. 313-314.

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3. *p*. United States Practice in Valuing Water Works Systems. By J. P. Wentworth. Pp. 70-76.
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25. Effect of Grounding Electrical Currents on Pipes. P. 12.
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6. Ressources en Eau de la Region Sudest du Massif Central. Pp. 34-37.
7. Nouvelle Methode de Filtration. Pp. 40-41.
8. Le Charbon Active et Son Emploi Dans le Traitement de l'Eau. By H. Descroix. Pp. 42-47.

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W *Johnson Nat'l Drillers Journal*

March-April

1. The Legal Status of Underground Water. Pp. 1-5.

Lowering Water Main Under Pressure

When the mains of the Tifton, Ga., water supply system were first laid, the trenches were dug very shallow, and later street improvement still further reduced the cover in many places, so that the mains were entirely uncovered; and service lines were 2" to 3" above the street at the curb line in many places, the average cover being approximately 12".

When in 1938 it was proposed to pave some streets with WPA labor, it was decided to lower the pipe therein first. The pipe was 6", 150 lb b & s, 12 ft. lengths, calked with lead. Service connections were ½" galvanized pipe and ⅝" cocks with lead goosenecks.

The first step was to uncover the services, where they were not already exposed. The mains then were uncovered, one 560 ft. block at a time, the trench being made 5 ft. wide (4 ft. would have been sufficient). The trench was then continued down to a depth sufficient to give the pipe 4 ft. cover, except that a section of earth across the trench was left under each length of pipe about 2 ft. in front of the bell, to support the pipe. These were about 18" measured lengthwise of the trench, but when the rest of the trench had been dug to grade they were cut to 8", and then the earth gradually lowered on one side and under the pipe, the sides lowered alternating in successive supports so that the pipe would remain in line. This was continued until the pipe had settled to its new level, when it was re-aligned and recaulked.

The plan was made possible by the fact that the soil was very stiff clay and sand. With sand or other loose soil it would not be practicable. Thirty-six hundred feet of pipe has been lowered, with no breaks and no major leak occurring.

The approximate cost for labor has been 82.6 cts. per foot of pipe lowered, which is considered excessive.

Getting Ready for Safe Swimming

The Minnesota Conservation Service advises that every agency in charge of a beach should do the following before the swimming season opens: (1) remove all debris from the beach bottom; (2) mark with warning signs or eliminate entirely all drop-offs within a radius of 100 feet of the bathing beach proper; (3) reconstruct and relocate water front equipment along proven safety lines; (4) see that the men chosen as the guardians of the lives of the children are certified life savers chosen solely on merit. This minimum of safety may feasibly be supplemented by providing beach amusement devices and games, and by undertaking an educational campaign which will sell the beach to the public and urge parents to see that their children swim only at the supervised public beaches.

Low-Height Dump Trucks for Street and Refuse Work

By J. L. Parsons, City Engineer and Street Supt.

In the spring of 1937 the City of Fort Dodge, Iowa, was in the market for a new 1½ ton truck with hydraulic dump for street department purposes. After a study of the truck equipment then owned by the department, it was found that all of the dump boxes in use were too high above the ground, thus necessitating extra and unnecessary hand labor in the many types of work connected with street work, such as loading snow, street refuse and gravel. The average heights of the tops of

dump bodies above the ground was found to be approximately 5′-3″.

The principal request made by the Superintendent of Streets of the Commissioner of Streets, R. D. Mitchell, was that this height be considerably reduced in future purchases. After a thorough investigation it was found that, with the types of trucks and dumps on the market, this height could be reduced satisfactorily only by purchasing a truck from a manufacturer specializing in under-slung frames and small wheels. With the cooperation of the Anthony Co. a dump was attached with long, wide and shallow dimensions giving a resulting over-all height of top of dump box 4′-3″ above the ground.

A year later another truck was purchased and standard sized wheels were used because of the fact that in the meantime the Anthony Co., at the suggestion of the city, had re-designed and lowered their hoisting apparatus with the result that their dump box could be attached to the 2-ton chassis purchased with an over-all height of 4′-3″.

The popularity of these low dump trucks with the street workmen was immediate and pronounced to such an extent that attention was given to reducing the height of all dump trucks as much as possible. In the case of two of the older trucks, this was accomplished by replacing the high dump box on one with the new type of box and by cutting down the sides of another dump box 10 inches with a torch. The capacity of all these truck boxes is ample for all heavy materials, and for snow and other light materials the capacity is readily increased by the use of side boards.

The street department of the city now owns a fleet of six trucks, five of them having a maximum over-all height of 4′ to 4′-3″ and one having a height of 4′-8″.

Until disproved, the City of Fort Dodge, Iowa, makes the claim of having a fleet of trucks with the lowest over-all height of dump boxes of any city street department in Iowa and perhaps in the United States.

Sweeping Streets by Machine Proves Economical

Rochester, Minn., has 35 miles of paved streets —six of downtown business streets and 29 of residential streets. To keep these clean, the city last fall purchased a patrol sweeper (Austin-Western). Sweeping starts at midnight, when traffic and parking are lightest; the business section is cleaned every other night, and the residential portion at least twice a week.

All-night parking is troublesome for any kind of street cleaning. Rigid enforcement of an ordinance prohibiting all-night parking or providing terminal parking space so that streets are clear of cars after midnight is the most satisfactory solution. Community pride in clean streets is a part of an educational process toward public acceptance of parking restrictions to facilitate night cleaning and public cooperation increases with proper publicity and understanding.

The experience in the first one hundred hours of operation indicates that an equipment rental rate of $1 per hour will cover all equipment costs, including operation and maintenance costs and depreciation. Costs per gutter-mile, to date, average approximately forty cents. The sweeper is operated by one man and does a complete job since it picks up the dirt as it sweeps. When the hopper is full, the rear broom is raised and the collected sweepings dumped in a convenient place along the route where it is collected by truck crews. The work is under the general supervision of Arleigh Smith, city engineer.

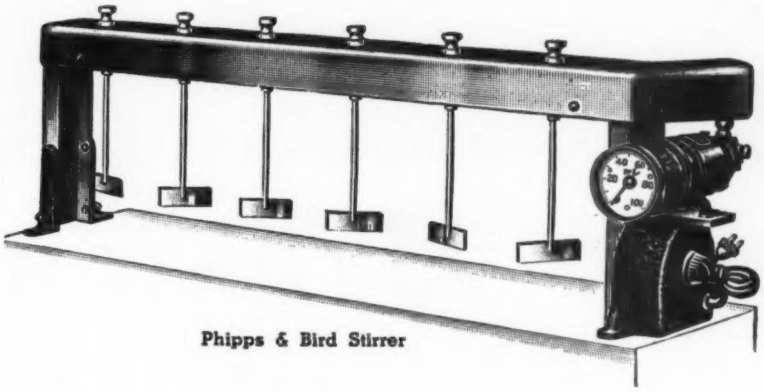
Keeping Up With New Equipment

Treating Swimming Pool Water

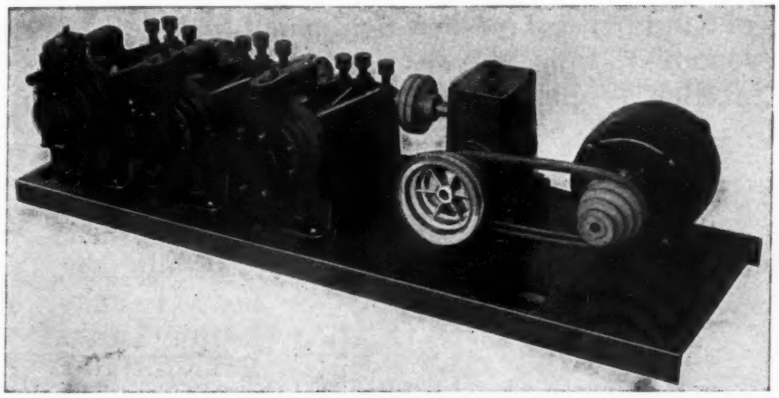
The Proportioneers triplex feeder is especially adapted for swimming pool installation. This unit will handle soda ash for pH control, aluminum sulphate for coagulation prior to filtration, and hypochlorite solution for sterilization, and is therefore especially designed for pools in which the water is recirculated and filtered. On pools that are of the drain and fill type, a chloro-o-feeder is attached to the line from the pump to the pool, and chlorinates all water entering the pool. On flowing through pools, in which water is added more or less continually, a similar unit is mounted on a water meter on the intake line and adds chlorine in proportion to the amount of water entering the pool.

Generally the residual chlorine content of pools should be maintained at about 0.5 ppm. at the inlet end, and at 0.1 ppm. or slightly more at the outlet end.

A bulletin on swimming pool water treatment is available from Proportioneers, 9 Codding St., Providence, R. I.



Phipps & Bird Stirrer



Proportioneers Triplex Feeder

This Mixer Saves Time and Chemicals

Something that ought to be in every water and sewage plant laboratory; allows you to make six jar tests at a time. Not necessary to guess at chemical dosages. Precise speed control with speed indicator control permits mixing of samples under desired conditions. Paddles are stainless steel, chain driven, and may be lifted for removal or insertion of jars. Speeds 10 to 100 rpm.; 110-volt, ac or dc current; speeds to 200 rpm furnished on request. Phipps and Bird, Inc., Richmond, Va., manufacture this.

Four Lightweight Centrifugal Pumps

Gorman-Rupp Co., Mansfield, Ohio, has issued new bulletins describing four new lightweight self-priming centrifugal pumps. The Midget weighs 52 pounds and handles 5000 gph; the Bantam weighs 79 pounds and handles 7500 gph; the Hawk weighs 97 pounds and handles 10,000 gph; and the Eagle weighs 104 pounds and handles 15,000 gph. Circular CT-2 and Bulletin CT-5 describe these.

Centrifugal Driers and Wedge-Wire Screens

A new folder describing the use of Carpenter centrifugal driers for all places where there are granular materials to be dried, has been issued by Koppers-Rheolaveur Company, Pittsburgh, Pa. Features claimed for the Carpenter driers include: Maximum moisture removal; large capacity; continuous feed, which reduces power costs. Koppers wedge-screen are described in a leaflet.

Galion Heavy Duty Motor Patrol

Galion Iron Works & Mfg. Co., Galion, O., has announced a new heavy duty motor grader powered with a 66 hp diesel engine. This machine, without the scarifier, weighs about 21,000 pounds. Wheelbase is 18 ft. 11 ins. There are 8 speeds up to about 16 m.p.h., and 2 reverse. Controls are hydraulic. The blade is 12-ft. This is more than a maintenance machine, since it is heavy enough and powerful enough to carry out many construction operations that previously were possible only by tractor-drawn equipment. Described in Bulletin 237, which will be sent on request.

The new heavy duty Galion motor grader

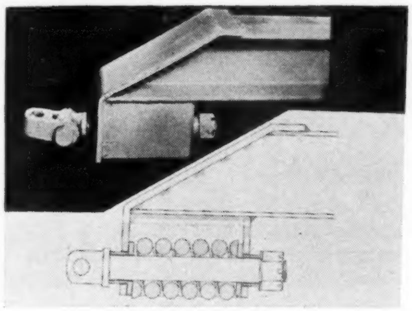
When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 70 to 73

Recirculating Systems for Swimming Pools

Bulletin 2010, International Filter Co., Chicago, Ill., discusses the advantages of recirculating system and also their operation, with special reference to gravity filtration. Excellent illustrations. Units available for capacities of 750 to 2500 gallons per minute are discussed.

New Design Hitch for Sheepsfoot Rollers

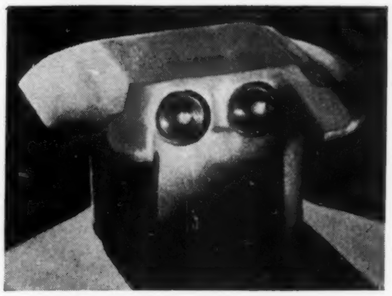
Blaw-Knox Company announces a new design of hitch for its sheepsfoot tamping rollers. Heretofore it has been the practice on tractor drawn equipment to provide a compression spring which functions in the direction of forward pulling. The improved spring hitch is designed to function in both directions, thereby providing for reduction of impact and shock loads whether the tractor is drawing forward or backing up. As indicated in the illustration, the double action is achieved through a special mounting of the spring.



Sheepsfoot roller hitch

Galion International Roller

This is a variable weight roller with a basic weight of 4 tons, which can be increased to 5 tons by water ballast. An International 1-30 power unit is provided. It is designed for light rolling, including patch and repair work, shoulder maintenance, resurfacing and light construction. Fuller data from Galion Iron Works and Mfg Co., Galion, O.



Owl-Eye highway marker

"Owl-Eye" Safety Highway Marker

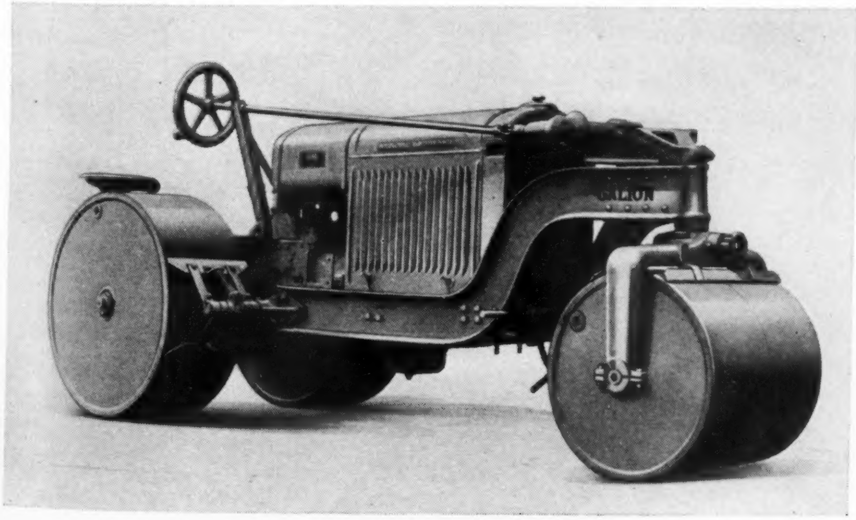
A new marker, designed to be installed in a road in place of a white center line, has been developed by the Hi-Way Safety Marker Company, 206 Merritt Street, McKeesport, Pa. It is built of an aluminum alloy casting, with four reflector buttons. When crystal reflector buttons are used, the marker shows up well in fog.

In addition to its use as a center-line guide, the marker can be used on curves and at city intersections. As an added safety feature, the top surface is grooved to prevent skidding. The close-fitting reflector buttons are protected from tires and chains.

An air drill is used in installing the marker. That part of the marker which is cemented in the highway is 1¼ inches long and has an outside diameter of 2¼ inches. When high early strength cement is used, the highway can be ready for traffic in 3 hours.

Material Handling, Chains and Power Equipment

Jeffrey Mfg. Co., Columbus, O., has issued a 960-page general catalog covering conveyors, elevators, chains, sprockets, transmission machinery, electric vibrating feeders, screens, coolers, dryers, crushers, pulverizers, shredders, portable loaders and conveyors, and other equipment. Make request on your letterhead for Catalog No. 87.



Galion patching and maintenance roller

Readers' Service Department

These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

Construction Materials and Equipment

Air Compressor from Ford Parts

5. How you can convert an ordinary Ford model A or B motor into an air compressor for operating jackhammers, paving breakers, clay spaders, tampers, paint sprays, etc., is explained in a new bulletin just issued by Gordon Smith & Co., Desk G, 516—10th St., Bowling Green, Ky.

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride with Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Dirt Moving Efficiency

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by Internaional Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

66. Where loading is done by hand, the Load Lugger, with your small truck, will cut costs tremendously. Simple, low in price. Especially adapted to city, county and town work. Complete details on request. Brooks Equipment & Mfg. Co., 56 Davenport Road, Knoxville, Tenn.

67. "Modern Methods of Moving Earth" is an 88-page illustrated book explaining earth moving by tractor power. Tells what types of equipment is most efficient for each class of work and includes estimated costs of the different methods on average jobs, short cuts in estimaing, etc. Sent only to those having earth moving problems by Cleveland Tractor Co., 19,300 Euclid Ave., Cleveland, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches—for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Culvert Mfrs. Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

Finisher

78. A very complete, 36 page illustrated booklet on the Barber-Greene Tamping-Leveling Finisher explains its important features, principles of operation, types of jobs it handles and materials laid. Ask for catalog 879, Barber-Greene Co., 635 West Park Ave., Aurora, Ill.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contract-

(Continued on page 70)

Readers' Service Department

These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

(Continued from page 69)

ing and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrtions.

Paving Materials, Gutters

119. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Just issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

125. Homelite portable, self-priming, centrifugal pumps in sizes from 2" to 3" are fully described and illustrated in new folders. Homelite Corp., 2406 Riverdale Ave., Portchester, N. Y.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Mfrs. Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenace

127. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

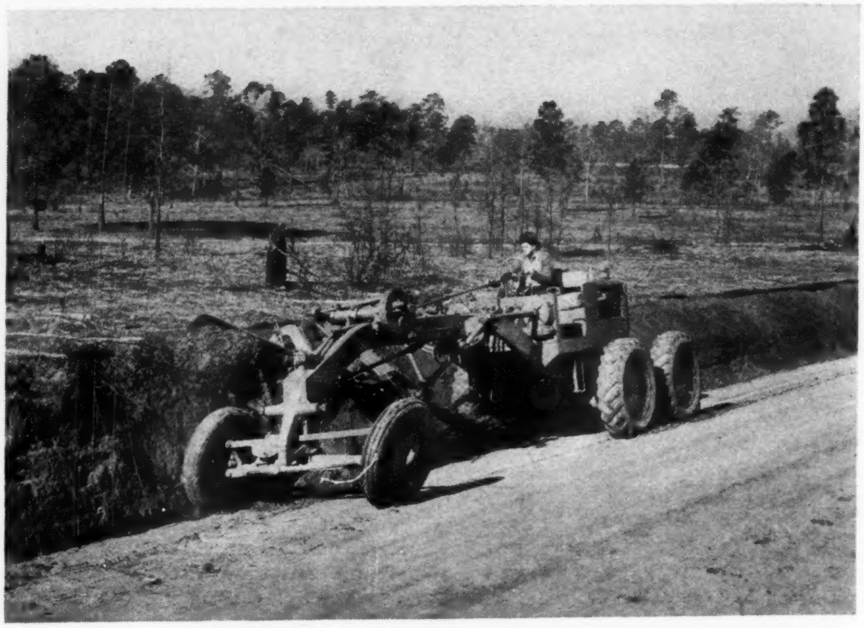
Rollers

130. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg. Co., Marion, Ohio.

132. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

133. New Tu-Ton roller of simple construction for use in rolling sidewalks

(Continued on page 71)



New 112 Caterpillar Motor Grader

New Caterpillar Motor Grader

A new motor grader, the No. 112, has been announced by Caterpillar Tractor Co., Peoria, Illinois. This is available with either gasoline or diesel engine. Both have four cylinders and develop 46 maximum horsepower at 1500 r.p.m. The 12′ blade will reach more than 6′ outside the line of wheels and can be set to cut banks up to 90 degrees. The blade can also be turned completely around.

In the reverse position, the blade can be set for ditching or blading, permitting working back and forth on one side of a regrading job without turning the machine around. A change from full ditching to bank cutting position takes less than one minute. There are 7 forward and one reverse speeds. Low pressure tired tandem or single drives are available. With the diesel engine and tandem drive, the No. 112 weighs 17,800 pounds, with more than 13,000 pounds of this weight carried by the driving wheels. Attachments include a V-type scarifier, a straight type scarifier, a V-type snow plow and a roller. Standard equipment includes leaning front wheels and two braking systems, one hydraulic and the other mechanical.

A Streamlined, High-Speed Mower

This is a new mower by Toro Mfg. Co., Minneapolis, Minn. It is designed especially for roadside mowing, and in addition, it is a most attractive piece of equipment, which the maintenance men will all want to drive. Toro says: 6-cyl., 60 hp engine; speeds 3 to 45 mph; wheelbase 71 ins. to give short turning radius; cuts any angle from 90° above to 45° below; independent power for the cutter; works fine on slopes; power raises sickle bar in 2½ seconds; standard width rear tread, single or dual tires. Burnt orange lacquer with aluminum trim. Fine booklet from maker on request.

The Toro streamlined highway mower

Projecto Floodlight

New "Projecto" Floodlight

The "Projecto" floodlight is designed as a practical general-purpose fixture for illuminating grounds, buildings, service stations, parking lots, athletic fields, etc. It is finished in permanent porcelain enamel which is easily cleaned, and retains, even after years of exposure, its consistently high factor of reflection. The "Projecto" floodlight may be pole-mounted or attached to walls and other flat surfaces by means of a bracket arm which provides universal adjustment so that the light may be directed where needed. Made by Goodrich Electric Company, 2900 N. Oakley Ave., Chicago, Illinois.

The Accelator for Water Softening

A new development in water softening is the Accelator, which has been developed by International Filter Co., Chicago, Ill. In this device, it is claimed that the softening reactions are accelerated, and that clarification takes place without sedimentation, resulting in a radical reduction in the space required for the installation. Bulletin 1820 describes this new unit.

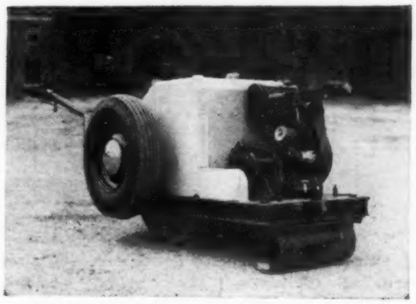
Modern Power Transmission Units

Link-Belt Co., Chicago, Ill., has issued a new 272-page book listing modern power transmission units, with complete design and application data, dimensions, weights, list prices, etc., with complete cross-index. Request for this book may be sent to Link-Belt at Chicago, Philadelphia or other office.

The Improved Littleford Motorized Wheeled Roller

The improved Littleford Model 150 Motorized Wheeled Roller is designed for patch and restoration work. It can be attached to any maintenance truck for movement. The "tongue up-and-over" principle changes it from a trailing position to the rolling position and visa versa in 60 seconds' time.

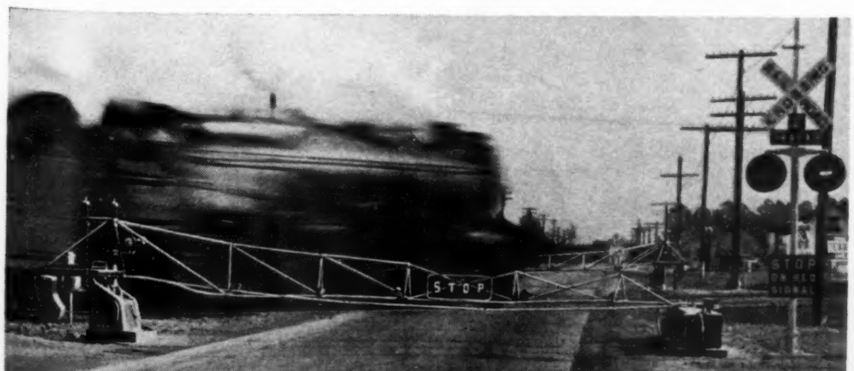
This wheeled roller was designed for Street and Highway Departments, Contractors, Parks, Cemeteries, Airports, Street and Steam Railways, and Public Utilities. With this roller, patch rolling can be done at extremely low cost because this roller can be moved without delay and to any destination. Further information from Littleford Bros., Cincinnati, Ohio.



Littleford wheeled roller

Automatic Grade Crossing Protector

A new automatic crossing gate has been announced by Atlantic Steel Castings Co., Chester, Pa. This does most everything but scold the driver. Approaching trains lower the gates and turn on flashing red lights. The protector consists of an arc-shaped gate of steel with two strong cables forming the string to the bow, the concave side facing the approaching driver. The end of the gate fits over a hydraulically equipped post, so that cars striking the cables are brought to a stop comparatively gently. It is claimed that a car traveling 50 miles an hour is stopped without serious damage to the car or the occupants, though the fenders and radiator grill may be bent.



This crossing protector does everything but scold the driver

Readers' Service Department

(Continued from page 70)

along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3846 No. Palmer St., Milwaukee, Wis.

Shovels, Cranes and Excavators

145. The Austin-Western-Badger, a fully convertible ½ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5 Aurora, Ill., is fully described and illustrated in their Bulletin No. AD-1683.

146. New catalog picturing the detailed construction of Osgood "Chief" power shovel and illustrating it as shovel, clamshell, dragline, crane and piledriver. Write The Osgood Co., Marion, Ohio, for your copy.

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

152. The Columbia Alkali Corporation, Barberton, Ohio, will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing The Columbia Alkali Corporation, Barberton, Ohio.

154. "Soil Stabilization with Tarvia" —An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Company, 40 Rector St., New York, N. Y.

155. "Better Bases for Better Roads" is a useful new booklet describing and illustrating the use of calcium chloride stabilized graded aggregate mixtures for pavement bases. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Steel Forms

160. Complimentary Bulletin S-19-F, issued by The Heltzel Steel Form and Iron Co., Warren, Ohio, contains complete information on the use of steel forms for constructing concrete curbs, curb and gutters and sidewalks.

Trailers

170. A fast loading and fast hauling trailer is illustrated and described in a 12-page folder by Meili-Blumberg Corp., New Holstein, Wis. The platform tilts for safe, easy, one-man operation. Initial cost is low, upkeep negligible, capacity up to 10 tons. Write Meili-Blumberg for folder.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

HOW TO ORDER: These booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

(Continued on page 72)

Readers' Service Department

(Continued from page 71)

Pouring Pots

265. Full line of welded, screened and hooded pots, light, strong and accurately balanced, designed for maximum savings. Send for literature and prices to Tarrant Mfg. Co., 12 Maple Ave., Saratoga Springs, N. Y.

Street Cleaner's Can Carriers

290. "Street Sweepers' Friend," an improved roller bearing and rubber tired can carrier is described and illustrated in a new pamphlet which will be sent promptly on request by the Tarrant Manufacturing Co., Saratoga Springs, N. Y.

Sweepers, Rotary

300. "Frink Roto-Broom," a 4 page bulletin illustrating and describing a new rotary sweeper by Frink. Attaches to front of and makes a sweeper of any motor truck. Used by street and highway departments, parks, airports, playgrounds, arenas, coliseums, etc., for sweeping dust, dirt, sand, gravel, cinders, leaves or snow. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Snow Fighting

Plows

349. "Frink V Type Sno-Plows" is a 24 page catalog fully illustrating and describing 8 models of V Type Sno-Plows for motor trucks from 1½ up to 10 tons capacity, 16 models of Frink Leveling Wings, the Frink Hand Hydraulic Control and the latest Frink Selective Power Hydraulic Control. Data are given for selecting the proper size V plow and wing for any truck. Issued by Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Sanitary Engineering

Anaylsis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use," is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

375. This concise folder No. 1294 describes "Straightline Aerators" for activated sludge treatment; combines these features: 1, rapid circulation in the tanks; 2, exposure of large surfaces, hastened oxidation and bacteriological growth. Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

380. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Aerators for Sewage

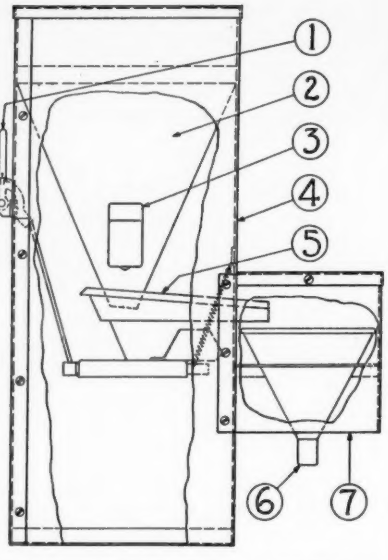
381. New 24 page booklet, No. 6571 describes and illustrates the Dorrco Paddle Aerator and also the Turbo-Aerator. Also contains a discussion of the activated sludge method of treatment with much interesting data and illustrations, including a section of "Useful Information." Issued by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Cast Iron Sewers

384. Cast Iron Pipe for Sewers. Cast Iron Pipe has beam strength, resistance to crushing stresses and infiltration-proof joints making it highly desirable for flow lines, force mains, submarine lines, outfalls and sewage treatment plants. For specifications write U. S. Pipe and Foundry Company, Burlington, N. J.

Chemical Treatment

385. A handbook on the application of chlorine and iron salts in sewerage treatment. Tech. Publication 177. Wallace & Tiernan Co., Inc., Newark, N. J.



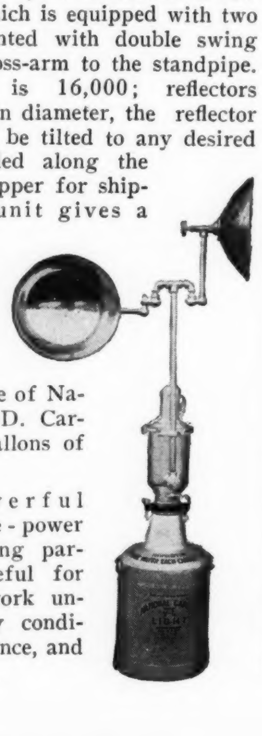
Syntron Dry Chemical Feeder: (1) Hopper opening adjustment; (2) chemical hopper; (3) hopper vibrator; (4) cabinet frame; (5) vibratory feeder conveyor; (6) earthenware solution pot; (7) solution pot cabinet.

Syntron Dry Chemical Feeder

This is a small capacity machine for water and sewage treatment plants, and is similar in construction to the larger Syntron feeders previously described. It is operated by 110-volt current, ac. The hopper has a capacity of 3 cu. ft. Operation is by means of a electric vibratory feeder trough, with a vibrator attachment to the hopper to insure continuous feed. The solution pot is earthenware. The entire machine is enclosed in a dust-proof housing. Rate of feed is controlled from a wall mounting. Full information from Syntron Co., 660 Lexington Ave., Homer City, Pa.

National Carbide V.G. Light

The National Carbide Corporation, New York, N. Y., has announced a new V. G. light which is equipped with two reflectors mounted with double swing joints on a cross-arm to the standpipe. Candle-power is 16,000; reflectors are 13 inches in diameter, the reflector standpipe may be tilted to any desired angle or folded along the side of the hopper for shipping. This unit gives a steady and exceptionally powerful light for about six hours on one 7-pound charge of National 14 N. D. Carbide and 7 gallons of water.



This powerful 16,000 candle-power light is proving particularly useful for construction work under emergency conditions, maintenance, and sewer work.

Readers' Service Department

Diesel Engines

386. Write Dept. 118, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill., for data on how the installation of F-M diesels has lowered taxes and made it possible for many communitines to pay for their improvements out of municipal power plant earnings.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from %Proportioneers, Inc.% 96 Codding St., Providence, R. I.

388. Chemical Feed Machines. Description, principles of operation; data on installation. E. W. Bacharach & Co., Rialto Building, Kansas City, Mo.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

Flow Meters

391. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Garbage Incineration

392. Send for full information about the Decarie Suspended Basket-Grate Garbage Incinerator which solves the garbage disposal problem of any city economically and with a minimum of space. Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

393. A special booklet on Municipal Waster Disposal Furnaces will be sent to all interested by The Goder Incinerator Corp., Chicago, Ill.

Gates and Valves

400. Gate, flap and check valves; floor stands and fittings. Pamphlet No. 30 gives detail information with dimensions for all types. M. & H. Valve & Fittings Co., Anniston, Ala.

Manhole Covers and Inlets

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe Cleaning

405. "Let's Look Into the Matter of Water Main Cleaning" is an illustrated booklet outlining the advantages of water main cleaning and explains how it can be done quickly and inexpensively by The National Method. Write National Water Main Cleaning Co., 30 Church St., New York, N. Y.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

408. Handbook of Universal Cast Iron Pipe and Fittings, pocket size, 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York, N. Y.

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Readers' Service Department

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Pipe, Concrete

409. Two excellent booklets, 12 and 16 pps., describe manufacture and installation of reinforced concrete pipe for gravity and pressure lines for sewage and storm drainage. Lock Joint Pipe Co., Ampere, N. J.

Pipe, Transite

410. This installation manual is a veritable mine of information on good practice in laying pipe and installing hydrants and valves. Write Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

416. For full details of Servitite plastic sewer pipe joint compound which it is declared will positively prevent root growth, write Servicised Products Corp., 6046 West 65th St., Chicago, Ill.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office, Memphis, Tenn.

Pumping Engines

424. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Run-off and Stream-Flow

426. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straight-line Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago Ill.

Meter Setting and Testing

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co. Wabash, Ind.

Rainfall Measurement

432. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Standard recorders for rain, snow and water level. Julien P. Friez & Sons, Baltimore, Md.

Small Septic Tanks

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 700 Brighton Ave., Syracuse, N. Y.

Sludge Drying and Incineration

439. The five basic steps of: sludge preparation; flash drying; incineration; deodorization; and dust collection are explained in a new 24 page booklet, No. 6781 issued by The Dorr Company, 570 Lexington Ave., New York, N. Y., sales representatives for the C-E Raymond system of sludge drying and incineration.

New Metal Pile Shoe

A new metal pile shoe which protects the ends of wood pile and prevents brooming, is being manufactured by The Union Metal Mfg. Co., Canton, Ohio. The shoes are available in two sizes to fit piles with tip diameters ranging from 5" to 14". They are made from heavy gauge rolled steel, formed in two sections and electrically welded together.

Shoe for piles

When driving wood pile through shale, gravel, rip-rap rock or other difficult soil conditions, it is claimed that the use of these metal shoes will not only prevent the ends of the piles from brooming but will enable the piles to be driven further into the ground in quicker time. The shoes are attached to the roughly sharpened end of the pile through the nail holes in each wing.

PERSONAL NEWS

Max C. Bartlett for 15 years with Burns & McDonnel Engrg. Co., has been appointed general manager of the Water & Lighting Dep't. of the Municipal Utilities of Knoxville, Tenn.

William H. Jackson, president of the Pittsburgh-Des Moines Co., died April 26th., at Pittsburgh, Pa. He was 71 years old and had been president of the company since 1921.

H. P. Mee has been elected executive vice president of the Cleveland Tractor Co., Cleveland, Ohio. Mr. Mee, who has been in retirement for the past two years, after twenty years of service in the tractor industry, was formerly vice president of Caterpillar Tractor Co.

Goslin-Birmingham Mfg. Co., 350 Madison Ave., New York, N. Y., are now handling the Conkey sludge filters, previously handled by Filtration Equipment Corp. George Dickey, one of the inventors of this filter, continues in charge.

Jeff Corydon of Proportioneers, Providence, R. I., has returned after a year's absence with his trailer-demonstrator, during which time he covered some 20,000 miles. The outfit is now being reconditioned preparatory to starting out again in New York and New England with Henry Armbrust at the wheel.

Krajewski-Pesant Mfg. Corp., New York, N. Y., has acquired the sluice gate and valve business formerly conducted by Coldwell-Wilcox Co. at Newburgh, N. Y. Frank G. Eldridge, who was designing engineer for Coldwell-Wilcox has joined Krajewski-Pesant and will be in charge of this division.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 216P East 45th St., N. Y.

Swimming Pools

443. "Pure as the Water You Drink"—a well illustrated booklet of useful data for engineer and contractor, on how to make your swimming pool sanitary, hygienically safe and inviting. Write Graver Tank & Mfg. Co., Inc., 4956 Tod Ave., East Chicago, Ind.

444. A new booklet "Essential Factors in the Design and Layout of Swimming Pool Systems," with data on filtration equipment, fittings, solution feeders, accessories, etc., is available from Everson Manufacturing Co., 213 West Huron St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

446. 40-page Manual on swimming pools. Includes swimming pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

447. "Painting Swimming Pools," an interesting booklet by Dr. A. F. Pistor, covers the subject thoroughly, discussing objectively the relative merits of the different types of coatings recommended for that purpose. Write Inertol Co., 401 Broadway, New York, N. Y.

Taste and Odor Control

448. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a booklet issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 77 pages, tables, illustrations and usable data.

Treatment

450. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

453. New booklet (No. 1642) on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

461. Ferrisul for Water and Sewage Treatment. Handy booklet describing Ferrisul and telling how it is used. Merrimac Chemical Div., Everett Station, Boston, Mass.

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

HOW TO ORDER

To obtain any of these booklets without obligation, send a post card to the firm whose name and address are given in the description and MENTION PUBLIC WORKS MAGAZINE. Or, if you prefer, send your request to Readers' Service Dept., PUBLIC WORKS, 304 East 45th St., New York, N. Y.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Marketing Sludge:

"A self-liquidating investment" is a bulletin that describes how sewage treatment plants may market sludge by reducing moisture content, shredding and aerating; also mixing in any desired enriching material. Royer Foundry & Machine Co., Kingston, Pa.

Telemetering:

A 16-page booklet gives a lot of information, with diagrams, covering equipment to transmit, indicate, record or integrate the measure of any factor, such as flow, level, pressure or temperature at any distant point. Sent on request. Bailey Meter Co., Cleveland, Ohio.

Subdrainage:

An excellent 32-page book on subdrainage has been issued by Toncan Culvert Mfrs. Ass'n., Republic Bldg., Cleveland, Ohio. This covers: Ground water and subdrains; methods of constructing subdrains; subdrainage installations for highways, airports, parks, golf courses, and many others; types of Toncan drainage pipes; and useful tables. Sent on request.

Wood Highway Bridges:

This is a booklet of about 70 pages. It gives data on typical types of highway bridges built of pressure treated timber, with engineering data, records of service life and maintenance. Well illustrated. Wood Preserving Corp. (a Koppers Co. subsidiary), Pittsburgh, Pa.

Concrete Shore Protection:

This is really a technical treatment of the subject. It begins with a discussion of wave action, including pressure, velocity, height and the factors influencing it, and similar data. About 15 pages are devoted to shore protection structures, including vertical face, curved and stepped walls, combination walls and light bulkhead walls; also revetment, groins and jetties. There is an excellent bibliography. The best information we know of on the subject, and should be in every engineer's library. Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

Water Wheel Generators:

Allis-Chalmers Mfg. Co., Milwaukee, Wisc., has issued a 16-page booklet on water wheel generators, well illustrated, which contains a list of a large number of installations from 31 kva to 65,000.

Eye Protection:

An 8-page booklet illustrates eye protection equipment for every job—goggles, spectacles, helmets, shields, etc. Ask for Bulletin CE-8, Mine Safety Appliances Co., Pittsburgh, Pa.

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